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# INSTRUCTION MANUAL
# FOR
# MODEL 7002
# T1 REPEATER/SECTION
# TEST SET

**7002**

**NORTHEAST ELECTRONICS CORPORATION**

P.O. BOX 649 – CONCORD, N.H. 03301

(603) 224-7466

ADDENDUM 1

MODEL 7002

Section 5 - Maintenance and Calibration

Battery Replacement. With reasonable care and periodic recharging, the nickel-cadmium battery should give satisfactory service for hundreds of charge-discharge cycles. As a measure of satisfactory service, a fully charged battery is expected to operate the set continuously for a day, or intermittently for a number of days. If the battery fails to give satisfactory service by this criterion, it should be replaced, preferably by six Gould Alkaline NICAD 4.0 SC Size D cells or their equivalent of another brand. Where nickel-cadmium batteries are not available, non-rechargeable dry cells of either carbon-zinc or alkaline manganese construction may be used in an emergency. Although such batteries are useful in an emergency, their life is not satisfactory for protracted use of the set, their performance at low operating temperatures is poor, their rechargeability is negligible, and constant care must be exercised to avoid leakage of electrolyte from run-down dry cells, which corrodes the interior of the set.

Caution: The manufacturers of nickel-cadmium batteries warn that complete discharge of multi-cell batteries usually results in permanent short circuit of one or more cells. Idle circuit current drain of the Model 7002 with the POWER switch ON is substantial and will run down the battery in a day or two. When the battery is to be charged overnight, make sure that the ac power for charging is not routinely turned off at night. The POWER switch should be ON only for charging or for actual use of the set.

INSTRUCTION MANUAL

FOR

# MODEL 7002

# T1 REPEATER/SECTION TEST SET

ISSUE 2

**NORTHEAST ELECTRONICS CORPORATION**

**P.O. BOX 649 – CONCORD, N.H. 03301**

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# SECTION 1

# DESCRIPTION

1.1 PURPOSE OF THE EQUIPMENT. The T1 Repeater/Section Test Set is designed to evaluate the performance of T1 line repeaters either in their operating environment or in a central office prior to installation.

1.2 There is provision for tests at the operating location to determine the proper value of Line Buildout Network (LBO) and to indicate or count bi-polar violations with either normal line termination, 100Ω termination or with the line looped or frogged. There is also provision for measuring line current, repeater voltage and error-free signal to noise margin under operating conditions.

1.3 For these tests, a probe and well are provided to permit the use of normal line current and line signal for the repeater. Measuring circuits are powered from a self-contained rechargeable battery.

1.4 Normal pre-installation tests made in the central office include signal to noise margin, continuity of repeaters equipped with line buildout networks and insulation leakage. These tests require that the set be connected to ac power and to a source of T1 line signal.

1.5 The set is portable and may be operated in either the vertical or the horizontal position. The cover is removable and provides storage for the probe and power cord.

# SECTION 2

## SPECIFICATIONS

RANGE: Line losses from 4.8 to 36.0 dB at 772 kHz in 2.4 dB steps. Signal to noise margins from 6 to 15.5 dB in 0.5 dB steps.

ERROR DETECTOR: Lamp indicates and counter registers individual bi-polar violations separated by 100 ms or more. Panel terminations provided for counting violations occurring more frequently.

INDICATING METER: Three scales, 0 to 200 mA, 0 to 16V with red mark at 7.2V for battery check and dB scale marked LO, MED, HI representing -1.2, 0, and +1.2 dB from nominal response.

INTERFERENCE GENERATOR: 770 kHz $\pm$ 100 Hz single frequency sine wave. Output impedance 5000Ω for bridging across repeater input. Maximum output about 300 millivolts peak, about half of normal signal level corresponding to a G Line Buildout Network.

LEAKAGE TEST: Applies 200V $\pm$ 10% between repeater circuit and case and indicates leakage resistance less than approximately 1 megohm.

POWER REQUIREMENTS: Self-contained 8.2V rechargeable battery of 4.0 ampere-hour rating, equivalent to more than 10 hours continuous operation. 105-135V ac, 50-60 Hz power required for central office pre-installation tests, 15 to 25 watts consumption, depending on the state of battery charge.

WEIGHT: 18 pounds

SIZE: $8\frac{3}{4}$" x 12" x 10 $\frac{1}{2}$"

TEMPERATURE RANGE: -40°C to +60°C

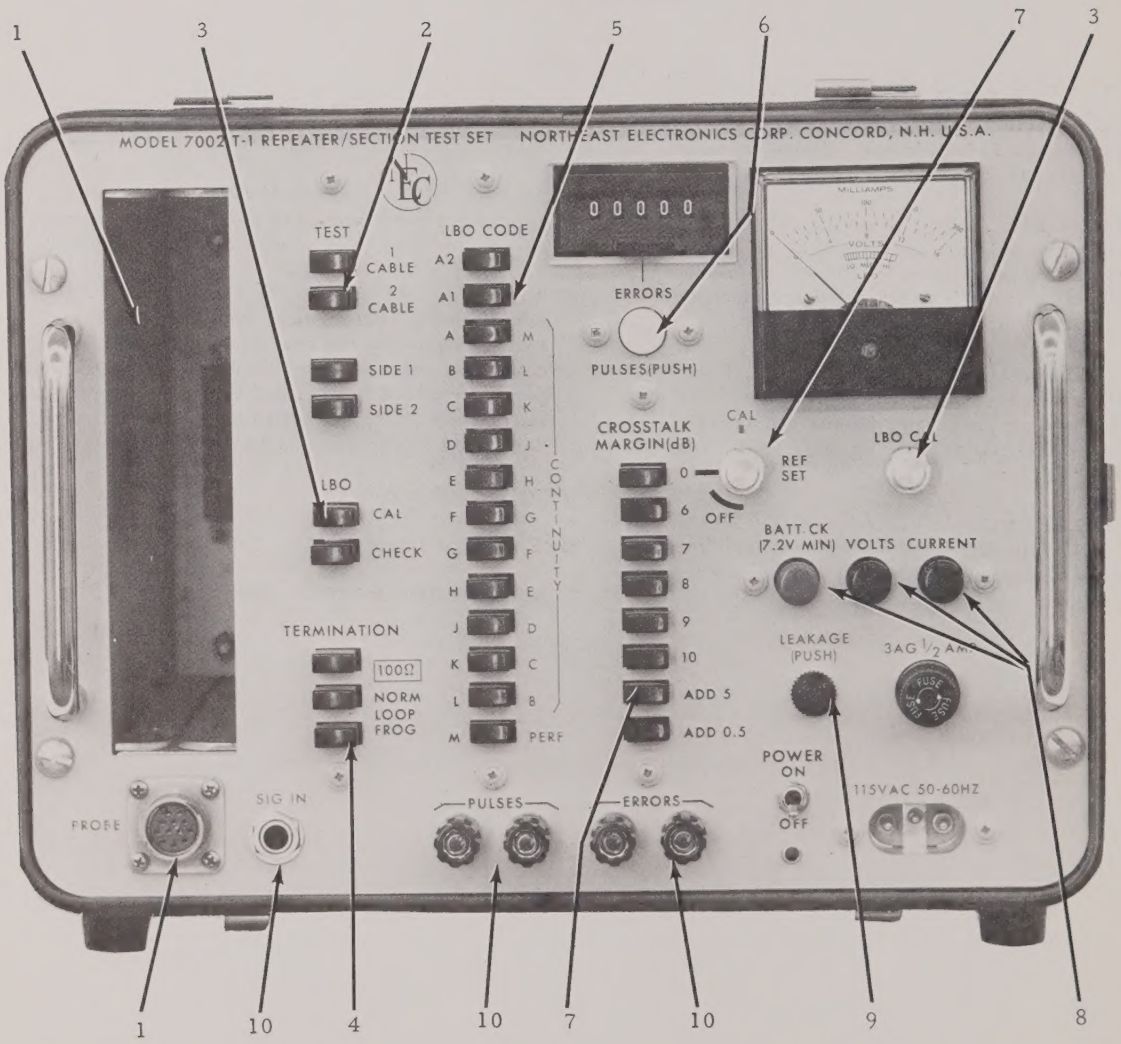



Figure 3-1 Front Panel Controls

# SECTION 3

## OPERATING INSTRUCTIONS

3.1 FRONT PANEL CONTROLS (See Fig. 3-1).

1. PROBE CONNECTOR and REPEATER WELL- provide access to repeater and line circuits. The well, with an insert where required, and a matching probe, fits any of the types of repeaters in common use. Insert and probe accessories are interchangeable, so that any set can be used with any type of repeater by providing the necessary accessories.

2. TEST Switches - Two pairs of pushbutton switches select 1-cable (bi-directional) or 2-cable (uni-directional) repeater configurations and side 1 or side 2 of the configuration selected.

3. LBO Switches - Non-locking CAL button connects detector to interference generator through calibrating pad and LBO CAL control. CHECK button sets up circuit for determining proper LBO.

4. TERMINATION Switches - Three pushbuttons, interlocked with CHECK button above, select either 100Ω termination, normal line termination or looped line for 1-cable (frogged line for 2-cable) configurations.

5. LBO CODE Switches - 14 pushbuttons interlocked so that normally only one at a time is operated. Button resulting in meter reading nearest mid-scale indicates optimum LBO. Blue scale indicates proper setting for performance test or for continuity test in central office when connected to ac power.

6. ERRORS-PULSES Switch and Counter- A lamp, housed in a pushbutton, indicates errors when they occur. If pulses are present, lamp lights when pushed.

7. CROSSTALK MARGIN Switches - 8 pushbuttons vary signal to noise ratio from 6 to 15.5 dB to determine tolerable noise level for error-free operation. Zero non-locking button, used with REF SET control for normalizing interfering signal to equal incoming signal.

8. BATT CK, VOLTS, CURRENT Switches- Three non-locking pushbuttons disconnect the meter from the LBO detector and connect it to measure battery voltage, repeater voltage and line current respectively. Operation of red BATT CK button results in a meter reading above the red line except when the battery charge is inadequate.

9. LEAKAGE Switch - A lamp in a pushbutton normally lights when 115 Vac power is ON. Operation of pushbutton extinguishes light except when leakage is excessive. Clustered around the switch is a POWER ON/OFF switch, a 3-pin connector for 115 V ac 50/60 Hz power cord and a 3AG $\frac{1}{2}$ amp replaceable fuse. The unmarked pushbutton below the ON/OFF switch is a battery cutoff which is operated when the cover is in place.

10. CIRCUIT ACCESS POINTS - The SIG IN jack accepts a 310-type plug for injecting a full-strength line signal for central office tests. A relay interlock with the ac power supply disconnects the jack when the set is operating on battery. The PULSES and ERRORS binding posts facilitate the connection of more sophisticated instruments such as oscilloscopes or high speed counters for special test. The PULSES binding posts may also be used to bridge the error detector across an external circuit.

3.2 OPERATION

a. The Model 7002 is a multi-function set which may either evaluate the operation of a T1 repeater and its associated line sections at a repeater operating point, or measure the performance of a repeater under controlled conditions in an office test.

b. At a repeater operating point, circuit access is provided by removing the repeater from its normal position, plugging it into the well in the test set, and plugging the test set probe into the normal repeater position. Line powering and signal path continuity are interrupted by this procedure but the powering is restored to normal when it is completed,

and the signal path is then under the control of the operator. About 0.2 dB loss is added in each signal input and output circuit, and about 10Ω resistance is added in the overall powering circuit. These small increments are negligible except in extremely marginal situations.

c. When access to the repeater and line circuits has been established as in b., measurements may be made of line current, repeater voltage, incoming signal level in terms of line buildout network code, and margin against interference. Crucial to the margin tests are the indications of the presence of pulses and absence of errors at the repeater outputs. These indications may be observed with repeaters terminated in their normal lines, in 100Ω resistors, or in looped or frogged lines.

d. In order to measure repeater performance in an office, the set is plugged into the 115-volt ac line and the POWER ON switch is operated. This starts charging the rechargeable battery in the set and also operates a relay which modifies the testing circuits for measuring repeater performance. A normal T1 line signal from either a bridging repeater or a fault-locating set adjusted for BIPOLAR output is patched to the SIG IN jack. The performance test made under these conditions is similar to the acceptance tests made at repeater manufacturing locations and is in close quantitative agreement with such tests. The set will also make a continuity check of a repeater with its line buildout networks in place or of a self-regulating repeater over any desired range of equivalent line lengths. A leakage test at 200 volts may also be made.

e. Whenever the panel meter is not in use its indicating needle should register zero on the scale. When necessary, readjust to zero with the mechanical zero-set on the meter case.

f. The counter is driven by the same circuit which flashes the ERRORS lamp in the ERRORS-PULSES switch and advances one count for each flash of the lamp (on ERRORS only). It may be reset to zero by depressing the reset bar on its face. The reset bar may be locked out by operating the small lever on its under side. The counter may be disabled by removing one of the connectors which complete the circuit to its terminals inside the case.

## 3.3 OPERATING PROCEDURE -LINE POWER TESTS

a. Operate BATT CK switch at any time to determine battery voltage under normal operating load. Battery should be recharged when voltage reading is less than 7.2V (marked by a red line).

b. Set the TERMINATION switch to NORM and the 1-CABLE, 2-CABLE switch to the position corresponding to the repeater being tested.

c. After making the necessary arrangements for interrupting power and transmission of the line to be tested, remove the repeater to be tested from its working position and insert it in the test set well. Insert the test probe into the working position from which the repeater was removed. The line is now normal with respect to powering and transmission.

d. Operate CURRENT and VOLTS switches one at a time and note that the line current and repeater voltage are within the expected range of variation.

## 3.4 OPERATING PROCEDURE -LBO CHECK

a. With the probe and repeater in test position as in 3.3c, and function switches set as in 3.3b, set SIDE 1, SIDE 2 switch to the side under test.

b. Operate non-locking LBO switch CAL, and while operated turn LBO CAL adjustment to set meter to mid-scale.

c. Operate LBO CODE switch corresponding to expected code of LBO network. Operate LBO switch CHECK. Meter should read between LO and HI on LBO scale. If it does not, operate LBO CODE switches one at a time until meter reads on LBO scale. The corresponding LBO code is the best selection for a repeater at this point.

## 3.5 OPERATING PROCEDURE-PULSES, ERRORS TEST

a. With test conditions set up as in 3.4a, operate TERMINATION switch to NORM and turn REF SET adjustment full counter-clockwise to OFF.

b. Operate PULSES -ERRORS switch and note that lamp in switch lights. This indicates that the repeater is delivering pulses.

c. Release PULSES-ERRORS switch and note that lamp in switch does not light. This indicates that the repeater is not delivering bi-polar violations.

d. If the results of steps b and c are not satisfactory, repeat both steps with TERMINATION switch operated to 100Ω or to LOOP/FROG. If errors appear with NORM or LOOP/FROG terminations and not with 100Ω termination, the repeater is probably satisfactory and one or both lines have impedance discontinuities. If all three terminations show errors, the repeater is probably at fault.

3.6 OPERATING PROCEDURE- MARGIN TEST

a. For line sections long enough to require repeater LBO codes A through G, operate LBO CODE switch to the code determined in 3.4c. (Repeater designers agree that a margin test is not significant in short line sections requiring LBO codes H through M, and no facilities are provided for such a test in this range).

b. Operate LBO switch CHECK and observe meter reading.

c. Operate non-locking CROSSTALK MARGIN switch 0, and while operated turn REF SET adjustment to get the same meter reading as in b.

d. Operate TERMINATION switch NORM.

e. Operate CROSSTALK MARGIN switches 10 and ADD 5.

f. Operate PULSES-ERRORS switch and note that lamp in switch lights. This indicates that the repeater is delivering pulses.

g. Release PULSES-ERRORS switch and note that lamp in switch does not light. This indicates that no bi-polar violations are delivered by the repeater.

h. Operate CROSSTALK MARGIN switches in turn to reduce attenuation in 1 dB steps until ERRORS lamp begins to flash. Increase attenuation 0.5 dB or 1 dB as required to stop the flashing. The sum of the CROSSTALK MARGIN switches in the operated position is the crosstalk margin. Values from 8 dB to 12 dB are usually considered satisfactory. The lower the value, the higher the performance of the repeater in the circuit.

i. If results in g are not satisfactory, repeat steps d through g with TERMINATION switch operated to 100Ω or to LOOP/FROG. Comparison with these results may indicate whether the repeater itself is defective or whether reflections from an outgoing line are contributing to a malfunction.

3.7 OPERATING PROCEDURE- OFFICE PERFORMANCE TEST

NOTE:

In a PERFORMANCE or CONTINUITY test in the central office, only one side of a dual repeater is under test while the other side is idle. Under some circumstances, the idle side will self-oscillate and induce errors in the side under test. The self-oscillation can usually be eliminated by momentarily operating the SIDE 1 - SIDE 2 switch to the idle side and back to the side under test.

a. Remove probe cord from PROBE connector. Connect power cord to 115V ac source and operate POWER switch to ON. The red lamp in the LEAKAGE switch should light, indicating that power is on.

b. Equip repeater to be tested with "A" buildouts, insert in well in test set and operate 1 CABLE or 2 CABLE switch to match repeater configuration.

c. Operate CURRENT switch. Meter should read between 130 and 150 milliamperes.

d. Operate TERMINATION switch to 100Ω and LBO CODE switch to PERF (blue designations).

e. Patch a full strength T1 line signal to the SIG IN jack using a 310-type plug. The signal should preferably be obtained from a working terminal or line either directly or through a bridging repeater. If such a signal is not available, the bi-polar output of a fault locating set may be used, setting it for PULSE PERIOD 4 and PULSE PERIOD 11 in turn.

f. Turn index of REF SET adjustment to CAL mark (blue designation).

g. Operate SIDE 1 switch.

h. Operate CROSSTALK MARGIN switches 10 and ADD 5.

i. Operate PULSES-ERRORS switch and note that lamp in switch lights. This indicates that the repeater is delivering pulses.

j. Release PULSES-ERRORS switch and note that lamp in switch does not light. This indicates that no bi-polar violations are delivered by the repeater.

k. Operate CROSSTALK MARGIN switches in turn to reduce attenuation in 1 dB steps until ERRORS lamp begins to flash. Increase attentuation by 0.5 dB or 1 dB as required to stop the flashing. The sum of the CROSSTALK MARGIN switches in the operated position is the crosstalk margin. Values from 8 dB to 12 dB are usually considered satisfactory. The lower the value, the higher the performance of the repeater in the circuit.

l. Operate SIDE 2 switch and repeat steps h through k.

3.8 OPERATING PROCEDURE- LEAKAGE TEST

a. With conditions set up as in 3.7a and b, operate LEAKAGE switch. The red lamp in the switch should extinguish. If it does not the repeater has lower leakage resistance than about 1 megohm.

3.9 OPERATING PROCEDURE-CONTINUITY TEST

a. With conditions set up as in 3.7a and b, remove "A" buildouts from the repeater under test and replace with the actual buildouts to be used in the final installation.

b. Turn REF SET adjustment full counterclockwise to OFF and operate TERMINATION switch to 100Ω.

c. Operate SIDE 1 switch and the LBO CODE switch (Blue designation) corresponding to the LBO network installed in side 1 of the repeater. Check for pulses and no errors as in 3.7i and j.

d. Operate SIDE 2 switch and the LBO CODE switch (Blue designation) corresponding to the LBO network in SIDE 2 of the repeater. Check for pulses and no errors as above.

# SECTION 4

## CIRCUIT DESCRIPTION

4.1 GENERAL DESCRIPTION. The block diagram of Figure 4-1 indicates the major functions performed by the T1 Repeater/Section Test Set. Each of the balanced transmission pairs connecting the probe to the repeater under test is coupled through a power-separation circuit consisting of two wideband, low-loss transformers. All transmission measurements are controlled in the unbalanced paths connecting through the function and terminating circuits. Signal input for preinstallation test (ac operation) is carried to the repeater through the LBO attenuator. The power leads from each power-separation circuit are routed to the power measurement circuits for monitoring purposes. When the set is operated from 115V ac the repeater is powered from the internal repeater supply. The dc leakage test and battery charging power is also derived from the line.

4.2 SIGNAL TRANSMISSION AND REPEATER POWERING. Figure 7-1 illustrates conditions for field operation on a two cable system, connected normally, with Side 1 under test:

a. The Side 1 transmission path enters the test set at probe terminals 3 and 4 and is carried through jack J1 and transformer T101, through the switching on PC 5 and T102 to the repeater well terminals J6-3 and J6-4. The repeater output connects from terminals J6-1 and J6-2, through transformer T103, T104 and jack J1 to probe terminals 1 and 2, which connect to the line.

b. The Side 2 transmission path for a 2-cable repeater enters the probe terminals 6 and 7, connects through J1, T105, PC5, and T106 to terminals 6 and 7 of the repeater. From the repeater output terminals 10 and 11, it passes through T107, PC5 T108 and terminals 9 and 10 to the line.

c. For a 1-cable repeater, the transmission path for Side 1 is the same as in (a) above; for Side 2, it is in the reverse direction of (b) above.

4.3 The line power path, normally simplexed on the balanced line pairs,is carried between the center taps of transformers T101 and T102, T103 and T104, T105 and T106, T107 and T108. Current sensing resistor R801 is inserted in the series path between T101 and T102. Operation of the CURRENT switch on PC 8 permits monitoring of the line current.

4.4 Voltage developed across the repeater power supply is monitored when the VOLTS switch on PC 8 is operated. The meter circuit is connected from the center tap of T102 to contacts of relay K4 on PC9 which when non-operated, completes the circuit to the center tap of T103. When relay K4 operates, the measuring point is transferred to the center tap of T106. The state of relay K4 is determined by the voltage sensing circuit consisting of transistors Q901, Q902 and associated components.

4.5 When the repeater under test is strapped for a looped power option, the dc voltage between center taps of T103 and T107 is 0; Q1 and Q2 are on; and relay K1 is operated. When the repeater is strapped for a through power option, there is always a dc voltage difference between T3 and T7; Q1 and Q2 are off, and relay K1 is non-operated.

4.6 When the set is operated from a 115V ac source, repeater powering is supplied from a current source on PC 4. The rectified and filtered line current is applied to Q403 and Q404, which operate as a constant current source adjustable with R425. This current is applied through contacts of K1 to T107, and is returned at T102. Other contacts of K1 connect T103 and R106 to complete the circuit for either looped or through repeater powering options.

4.7 The circuit consisting of CR419, R429, R430 and C404 applies 200V dc at DS1. Normally, DS1 is returned to repeater common through R1 and functions as an ac power indicator; when depressed, the return is to the repeater case. Thus, when there is little or no leakage from common to the case, the lamp will be extinguished; If the lamp remains illuminated a leakage is indicated.

4.8 While operating from 115V ac relay K3 on PC 5 will be energized. The repeater input will be carried over it's contacts, through the LBO attenuator on PC2 and the network formed by R501-R504, C501 and L501 to J2. The network complements the LBO networks on PC2 to provide a maximum of 31.2 dB of attenuaton between J2 and the repeater.

4.9 ERROR DETECTOR. (Fig. 7-4 ) The error detector is a hybrid of medium-power integrated logic elements and discrete transistor circuits. The logic convention is high true, with logical one (1) corresponding to +5 volts, and logical zero (0) corresponding to 0 volts.

4.10 The repeater output is transformer-coupled via T301 to switches Q310 and Q311, which respond to positive and negative going pulses, respectively. CR306 and R332 maintain a bias at slightly below the switching threshold. The gates of U301 function as Schmitt Triggers to interface the logic elements.

Assuming that at least one pulse has been received, the logical sequence is as follows: The trailing edge of the last pulse received causes one of the one-shot circuits formed by U302 to generate a relatively short pulse. This pulse sets the flip-flop to condition the gates of U303 such that the next pulse received will be inhibited if it is of opposite polarity. If a bipolar violation occurs (two consecutive pulses of the same polarity), its associated gate will be enabled and the pulse will be passed through the OR gate of U304.

4.11 The pulse in violation is applied to the pulse-stretching circuit formed by the remaining gates of U304 and Q313 - Q314, which extends the pulse duration to approximately 80 ms. The extended pulse is applied to drivers Q315-Q316 and Q317-Q318 activating lamp DS1 and Counter A. For each violation separated by 100 ms from the preceding one the lamp will flash and the counter will be advanced one count. Individual pulse violations are interfaced to J4 through Inverter Q312.

4.12 LBO ATTENUATOR AND PEAK DETECTOR. (Fig. 7-2) LBO ATTENUATOR: Switch S2 on PC6 selects one of the series R-L and shunt R-C sets which in conjunction with R201 and R202, form a bridged -T network having loss characteristics similar to 22 gauge cable. The nominal 772 kHz loss varies in 2.4 steps from B (2.4 dB) to M (26.4 dB); A is a metallic connection having no loss. Positions A1 and A2 add 2.4 and 4.8 dB of sensitivity, respectively, to the peak detector circuit.

4.13 PEAK DETECTOR: RF amplifier U201 and associated components form a preamplifier with cable-equalizing characteristics determined by the feedback components L213, R230, C275 and R231. The buffered output from Q201 is applied to the amplifier of Q202 and Q203 through gain control R233. CR201 and R202 in the feedback path compensate for the emitter junctions of Q204 and Q205, which serve as active diodes of a peak detector. The dc level across C222 and C223 is applied to the meter through normally closed contacts of switch 4 on PC 8. Expansion of the meter scale is accomplished by R245. R807 serves as a zeroing adjustment when the reference signal is applied to the detector.

4.14 CROSSTALK MARGIN CIRCUIT (Fig. 7-3) The crosstalk margin circuit is composed of an interference generator, crosstalk margin attenuator, LBO normalization attenuator, and bridging amplifier.

4.15 INTERFERENCE GENERATOR: The interference signal source is generated on PC 3 by the crystal-controlled Colpitts oscillator Q301, operating at 1.540 MHz. Q302 operates as a saturating amplifier to toggle flip-flop Q303 - Q304 which accomplishes the frequency division to produce a symmetrical 770 kHz square wave. L302, C309 and C310 convert the square wave to a sinewave signal which is buffered by Q305 and Q306. Two outputs are made available: One is the interference signal; the other is a calibration source.

4.16 CROSSTALK MARGIN ATTENUATOR: The 770 kHz interference signal is switched to a 100Ω pi attenuator on PC 7 through R806. Attenuaton is controlled by switch 3 : Interlocked sections provide 6, 7, 8, 9 or 10 dB; push sections provide additional 5 and 0.5 dB; momentarily activation provides 0 dB, and also transfers the output of the bridging amplifier from the repeater input to the LBO check circuit.

4.17 LBO NORMALIZATION ATTENUATOR: The output from the crosstalk margin attenuator is coupled to the ladder attenuator on PC3 with K2 unactivated. Interlocking operation of switch S2 on PC 6 inserts 0 through 14.4 dB of attenuaton corresponding to G through A LBO codes. Operation of H through M disables the interference signal. With K2 activated, 14.4 dB of attenuaton is inserted with M; all other switches disable the signal.

4.18 BRIDGING AMPLIFIER: The normalized interference signal is applied to the amplifier on PC 3. Buffer Q307 drives the complementory amplifier Q308-Q309 to provide high-impedance bridging of the interference signal across the repeater input. R325 serves as a dc balance adjustment.

4.19 BATTERY CHARGER AND VOLTAGE REGULATOR. (Fig. 7-5) The power required to operate the instrument and maintain charge on the batteries is derived from circuits of the power supply on PC 4. Six rechargable cells serve as the voltage source, varying from 8.2V at full charge to a cutoff of about 7.2V. The battery state is monitored upon operation of the BATT CHECK section of switch 4 on PC 8.

4.20 When operating from 115V ac, the line current is rectified and filtered to supply the 8 volt regulator comprised of Q401, U401 and associated components. U401 is connected as a difference amplifier to control the series-pass transistor Q401. CR404 serves as the reference input; R409 provides adjustment for the sense input. The output supplies current through R407 to maintain the cells at full charge, or in their absence, serves as supply for the 8V circuits and 5V regulator Output short-circuit protection is assured by diodes CR405 through CR408.

4.21 Q402, U401 and their associated components produce regulated 5V in a manner similar to the 8V regulator. R414 serves to adjust the reference input voltage, while R422 and R423 sense the output voltage. Diodes CR410 and CR411 provide output short-circuit protection.

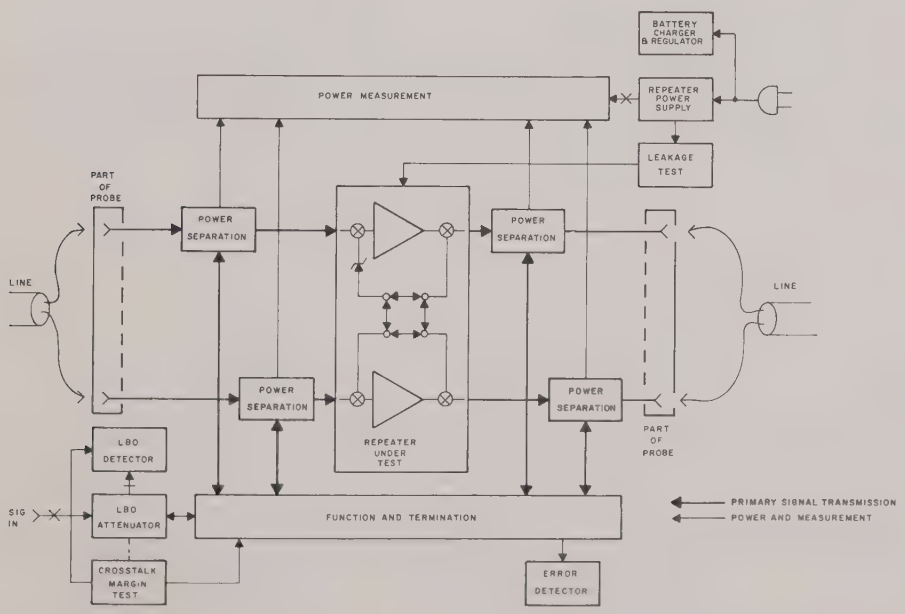



Figure 4-1 Model 7002 Block Diagram

# SECTION 5

## MAINTENANCE & CALIBRATION

5.1 BATTERY CHARGING. The nickel-cadmium cells require recharging when the battery test indicates less than 7.2V. Recharging is automatically accomplished when the set is connected to 115V ac with the power on. It is recommended that the batteries remain on charge for at least 8 hours when the voltage has dropped to 7.2V; if the cells have been allowed to discharge beyond this point, a correspondingly longer charge time will be necessary. An indication of approximately 8.2 volts may be considered as full charge. The charging characteristics prevent over charge, thus allowing the set to be continuously operated from the ac line while just maintaining the cells at full charge.

5.2 METER ZERO. The mechanical zero of the meter is factory set with the meter face in a vertical plane. If the instrument is to be operated with the panel up, or if the zero has been disturbed, adjust with a small blade screwdriver. To eliminate backlash, the recommended procedure is to adjust the pointer below the zero mark and then bring it back.

5.3 REPEATER CURRENT SUPPLY. When operating from the ac line the current supply is factory-adjusted to deliver 140mA to any repeater. If misadjustment is indicated, or if a different current is desired, perform the following procedure:

a. Loosen the four panel mounting screws and remove the set from the case.

b. Insert a repeater in the receptacle and connect the set to 115Vac; set power to ON and allow several minutes for stabilization.

c. Depress the CURRENT switch and adjust R425 (located at the top of PC4) until the meter indicates the desired current.

5.4 CALIBRATION. All internal power supply and other circuit adjustments are factory set and should maintain calibration throughout the use of the set. In the event that misadjustment is suspected, or if circuit components have been replaced, perform the appropriate checks and adjustments according to the following schedule:

| LOCATION | OPERATION | ADJUST | TO OBTAIN | AT TEST POINTS |
|---|---|---|---|---|
| PC4 | 115Vac; POWER ON; depress battery interlock (S8) | R409 | 8.5Vdc | 1 w/rspt to 3 |
| PC4 | POWER ON | R414 | 5.0Vdc | 2 w/rspt to 3 |
| PC2 | POWER ON; depress LBO CAL | R233 | 130mVrms | 1 w/rspt to 2 |
| PC3 | POWER ON | C309 | 715mVrms | 2 w/rspt to 1 |

# SECTION 6

## ELECTRONIC PARTS LIST

6.1 INTRODUCTION. The following pages contain the parts list for the Model 7002

6.2 FSCM Code Numbers. This is the Federal Supply Code of Manufacturers as issued October 1969. A list of codes and their respective manufacturers is given on page 6-2.

## LIST OF MANUFACTURERS

| Code No. | Manufacturer |
|---|---|
| 01121 | Allen Bradley Milwaukee, Wis. 53204 |
| 01295 | Texas Instrument Inc. Dallas, Texas 75231 |
| 02289 | Hi-G Inc. Windsor Locks, Conn. 06096 |
| 02660 | Amphenol Corp. Broadview, Ill. 60153 |
| 04221 | Midtex Inc. Div of Amco Mankato, Minn. 56001 |
| 05397 | Kemet New York, N.Y. 10017 |
| 06486 | IRC Div of TRW Inc. Lynn, Mass. 01905 |
| 06555 | Beede Electric Instrument Penacook, N.H. 03301 |
| 09353 | C&K Components Inc. Newton, Mass. 02158 |
| 09653 | IEI Brooklyn, N.Y. |
| 12065 | Transitron Electronic Corp. Boston, Mass. 02128 |
| 12697 | Clarostat Mfg. Dover, N.H. 03820 |
| 12954 | Dickson Electronics Corp. Scottsdale, Ariz. 85252 |
| 13606 | Sprague Electric Co. Concord, N.H. 03301 |
| 15873 | Motorola Inc. Arcade, N.J. 14009 |
| 17117 | Electronic Moulding Corp. Pawtucket, RI. 02860 |
| 17538 | Precision Electronics Mansfield, Mass. 02050 |
| 18043 | Profile Electronics Concord, N.H. 03301 |
| 18324 | Signetics Corp. Sunnyvale, Calif. 94086 |
| 18677 | Scanbe Mfg, Corp. Monterey Park, Calif. 91754 |
| 24446 | General Electric Co. Schenectady, N.Y. 12305 |
| 28480 | Hewlet Packard Co. Palo Alto, Calif. 94304 |
| 29525 | Hytronics Corp. No. Pinellas Prk, Fla. 33565 |
| 49671 | RCA Corp. New York, N.Y. 10020 |
| 71400 | Bussman St. Louis, Mo. 63017 |
| 71450 | CTS Corp. Elkhart, Ind. 46514 |
| 71590 | Centralab Milwaukee, Wis. 53201 |
| 71744 | Chicago Minature Lamp Chicago, Ill 60640 |
| 72136 | El-Menco Capacitors Products Co. Willimantic, Conn. 062260 |
| 72619 | Dialight Corp. Brooklyn, N. Y. 11237 |
| 72982 | Erie Technological Products Erie, Pa. 16512 |
| 75523 | Sodeco New York, N.Y. 10036 |
| 76493 | Miller J.W. Company Compton, Calif. 90024 |
| 78277 | Sigma Instruments Braintree, Mass. 02185 |
| 79066 | Valpey Corp. Holliston, Mass. 01746 |
| 80294 | Bourns Inc. Riverside, Calif. 92507 |
| 81073 | Grayhill Inc. La Grange, Ill. 60525 |
| 82389 | Switchcraft Inc. Chicago, Ill. 60630 |
| 94322 | Tel Labs Inc, Manchester, N.H. 03102 |

PC Bd. E95583

| Ref Desig. | Description | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| T101 thru T108 | Transformers Pulse 1:1:1:1 | 18043 | 4401-01-2818 |

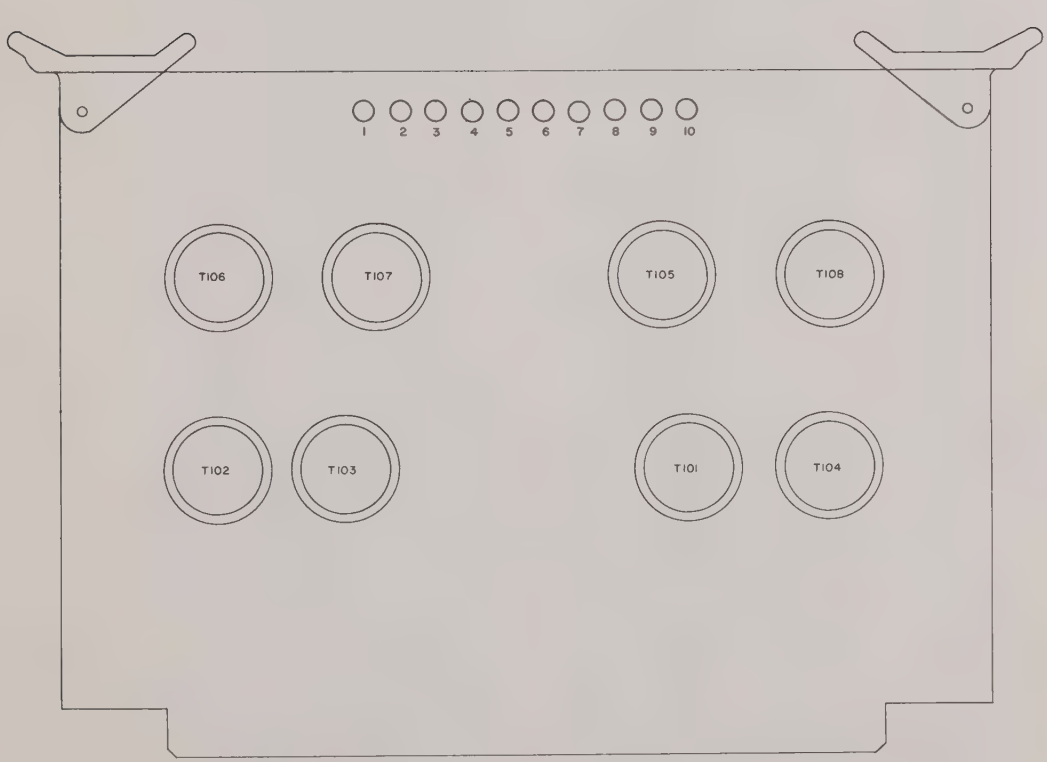



Figure 6-1 Component Location E95583

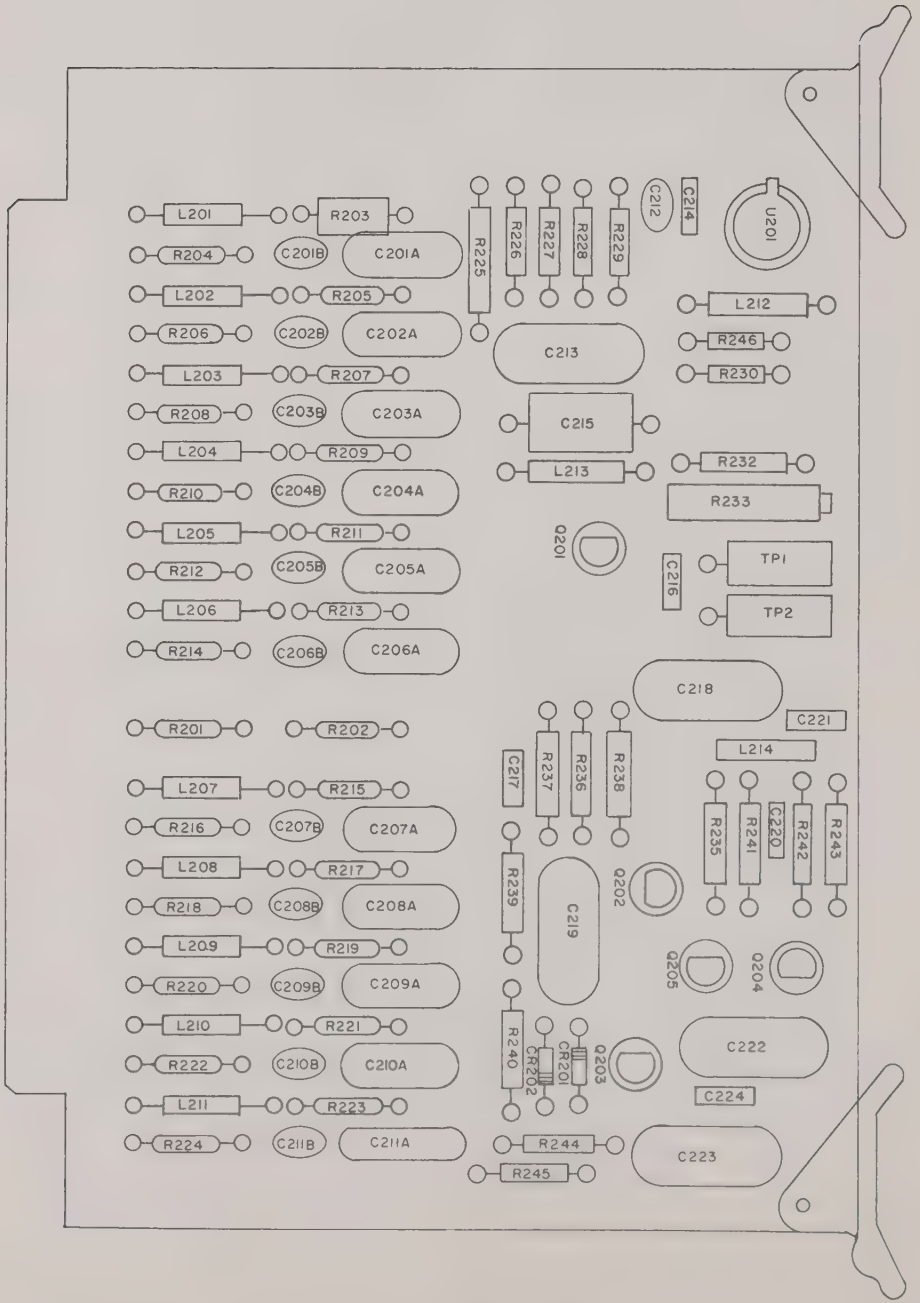



Figure 6-2 Component Location E95584

PC Board E95584

| Ref Desig. | Description | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| R201 and R202 | R: 100Ω 1/8W 1% mf | 06486 | CEATO |
| R203 | R: 9.53Ω 1/8W 1% mf | 06486 | CEATO |
| R204 | not used | | |
| R205 | R: 12.7Ω 1/8W 1% mf | 06486 | CEATO |
| R206 | R: 1050 1/8W 1% mf | 06486 | CEATO |
| R207 | R: 26.1Ω 1/8W 1% mf | 06486 | CEATO |
| R208 | R: 383Ω 1/8W 1% mf | 06486 | CEATO |
| R209 | R: 26.1Ω 1/8W 1% mf | 06486 | CEATO |
| R210 | R: 383Ω 1/8W 1% mf | 06486 | CEATO |
| R211 | R: 41.2Ω 1/8W 1% mf | 06486 | CEATO |
| R212 | R: 243Ω 1/8W 1% mf | 06486 | CEATO |
| R213 | R: 41.2Ω 1/8W 1% mf | 06486 | CEATO |
| R214 | R: 243Ω 1/8W 1% mf | 06486 | CEATO |
| R215 | R: 48.7Ω 1/8W 1% mf | 06486 | CEATO |
| R216 | R: 200Ω 1/8W 1% mf | 06486 | CEATO |
| R217 | R: 41.2Ω 1/8W 1% mf | 06486 | CEATO |
| R218 | R: 243Ω 1/8W 1% mf | 06486 | CEATO |
| R219 | R: 48.7Ω 1/8W 1% mf | 06486 | CEATO |
| R220 | R: 200Ω 1/8W 1% mf | 06486 | CEATO |
| R221 | R: 57.6Ω 1/8W 1% mf | 06486 | CEATO |
| R222 | R: 169Ω 1/8W 1% mf | 06486 | CEATO |
| R223 | R: 57.6Ω 1/8W 1% mf | 06486 | CEATO |
| R224 | R: 169Ω 1/8W 1% mf | 06486 | CEATO |
| R225 | R: 107Ω 1/8W 1% mf | 06486 | CEATO |
| R226 | R: 1330 1/8W 1% mf | 06486 | CEATO |
| R227 | R: 3480 1/8W 1% mf | 06486 | CEATO |
| R228 | R: 1470 1/8W 1% mf | 06486 | CEATO |
| R229 | R: 100Ω 1/8W 1% mf | 06486 | CEATO |
| R230 | R: 464Ω 1/8W 1% mf | 06486 | CEATO |
| R231 | R: 1330 1/8W 1% mf | 06486 | CEATO |
| R232 | R: 10K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R233 | R: 100Ω 10% ww var | 80294 | 3007P-1-101 |
| R234 | R: 390Ω $\frac{1}{4}$W 10% comp | 01121 | CB |
| R235 | R: 4.7K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R236 | R: 1K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R237 | R: 2.2K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R238 | R: 1K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R239 | R: 3.3K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R240 | R: 33K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R241 and R242 | R: 470Ω $\frac{1}{4}$W 10% comp | 01121 | CB |
| R243 | R: 100Ω $\frac{1}{4}$W 10% comp | 01121 | CB |
| R244 | R: 1780 1/8W 1% mf | 06486 | CEATO |
| R245 | R: 7500 1/8W 1% mf | 06486 | CEATO |
| C201A | C: 0.0015 100V 2% sm | 72136 | DM-20-152G |
| C201B | C: 27 pF 1KV 10% cer | 71590 | DD-270 |
| C202A | C: 0.0027 100V 2% sm | 72136 | DM-20-272G |
| C202B | C: 18 pF 1KV 10% cer | 71590 | DD-180 |
| C203A | C: 0.0039 100V 2% sm | 72136 | DM-20-392G |
| C203B | C: 100 pF 1KV 10% cer | 71590 | DD-101 |
| C204A | C: 0.0056 100V 2% sm | 72136 | DM-20-562G |
| C204B | C: 220 pF 1KV 10% cer | 71590 | DD-221 |
| C205A | C: 0.0075 100V 2% film | 72136 | 1MD-1-752G |
| C205B | C: 330 pF 1KV 10% cer | 71590 | DD-331 |

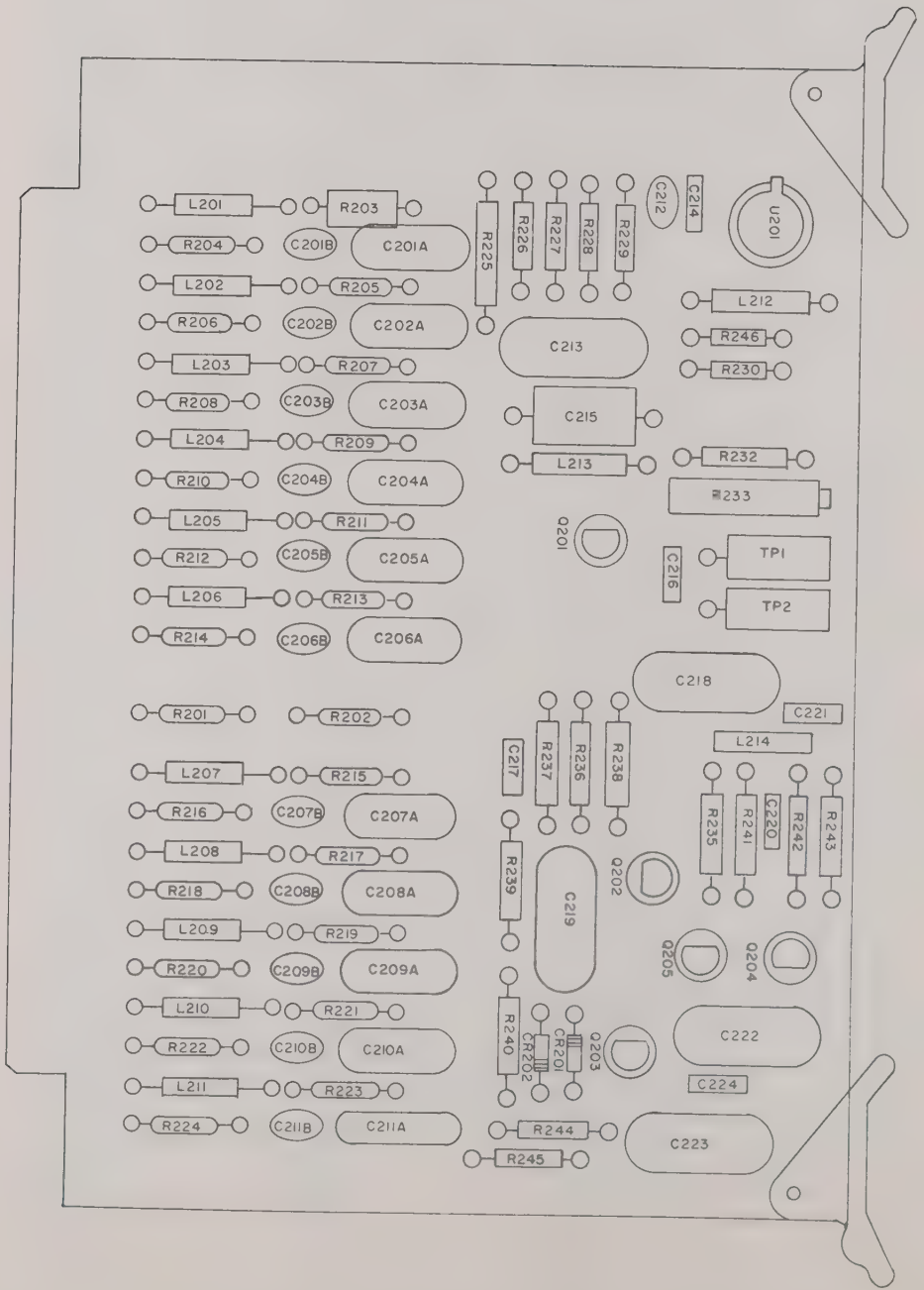



Figure 6-3 Component Location E95584

PC Board E95584 (cont)

| Ref Desig. | Description | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| C206A | C: 0.010 100V 2% sm | 72136 | 1MD-1-103G |
| C206B | C: 470pF 1KV 10% cer | 71590 | DD-471 |
| C207A | C: 0.012 100V 2% sm | 72136 | 1MD-1-123G |
| C207B | C: 150pF 1KV 10% cer | 71590 | DD-151 |
| C208A | C: 0.018 100V 2% sm | 72136 | 1MD-1-183G |
| C208B | C: 560pF 1KV 10% cer | 71590 | DD-561 |
| C209A | C: 0.022 100V 2% sm | 72136 | 1MD-1-223G |
| C209B | C: 1500pF 1KV 10% cer | 71590 | DD-152 |
| C210A | C: 0.030 100V 2% sm | 72136 | 1MD-1-303G |
| C210B | C: 1500pF 1KV 10% cer | 71590 | DD-152 |
| C211A | C: 0.039 100V 2% sm | 72136 | 1MD-1-393G |
| C211B | C: 1000pF 1KV 10% cer | 71590 | DD-102 |
| C212 | C: 100pF 1KV 10% cer | 72136 | DD-101 |
| C213 | C: 0.1 100V 10% cer | 13606 | 225P |
| C214 | C: 22 6V 10% tant | 05397 | K22W6K |
| C215 | C: 110pF 500V 2% sm | 72136 | DM-10-111G |
| C216 | C: 22 6V 10% tant | 05397 | K22W6K |
| C217 | C: 1.0 35V 10% tant | 05379 | K1RW35K |
| C218 and C219 | C: 0.1 100V 10% tant | 13606 | 225P |
| C220 and C221 | C: 22 6V 10% tant | 05397 | K22W6K |
| C222 and C223 | C: 0.1 100V 10% cer | 13606 | 225P |
| C224 | C: 22 6V 10% tant | 05397 | K22W6K |
| CR201 and CR202 | Diode silicon | 12065 | 1N4148 |
| Q201 | Transistor silicon PNP | 15873 | MPS 6519 |
| Q202 | Transistor silicon NPN | 15873 | MPS 6515 |
| Q203 | Transistor silicon PNP | 15873 | MPS 6519 |
| Q204 | Transistor silicon NPN | 15873 | 2N3903 |
| Q205 | Transistor silicon PNP | 15873 | 2N3905 |
| U201 | Integrated circuit wide band amp | 49671 | CA302B |
| L201 | Inductor molded 15μH 2.5% | 29525 | WEE-15 |
| L202 | Inductor molded 27μH 2.5% | 29525 | WEE-27 |
| L203 | Inductor molded 39μH 2.5% | 29525 | WEE-39 |
| L204 | Inductor molded 56μH 2.5% | 29525 | WEE-56 |
| L205 | Inductor molded 82μH 2.5% | 29525 | WEE-82 |
| L206 | Inductor molded 100μH 2.5% | 29525 | WEE-100 |
| L207 | Inductor molded 150μH 2.5% | 29525 | WEE-150 |
| L208 | Inductor molded 180μH 1.5% | 29525 | WEE-180 |
| L209 | Inductor molded 270μH 2.5% | 29525 | WEE-270 |
| L210 | Inductor molded 330μH 2.5% | 29525 | WEE-330 |
| L211 | Inductor molded 390μH 2.5% | 29525 | WEE-390 |
| L212 | Inductor molded 47μH 5% | 29525 | WEE-47 |
| L213 | Inductor molded 390μH 2.5% | 29525 | WEE-390 |
| L214 | Inductor molded 47μH 5% | 29525 | WEE-47 |
| TP1 and TP2 | Test jack rt angle | 17117 | 4879-125-9 |

PC Board E95585

| Ref Desig. | Dessription | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| R301 | R: 2.2K ¼W 10% comp | 01121 | CB |
| R302 | R: 33K ¼W 10% comp | 01121 | CB |
| R303 | R: 470 ¼W 10% comp | 01121 | CB |
| R304 | R: 10K ¼W 10% comp | 01121 | CB |
| R305 and R306 | R: 1K ¼W 10% comp | 01121 | CB |
| R307 | R: 9.1K ¼W 5% comp | 01121 | CB |
| R308 | R: 4.7K ¼W 10% comp | 01121 | CB |
| R309 | R: 22K ¼W 10% comp | 01121 | CB |
| R310 | R: 1K ¼W 10% comp | 01121 | CB |
| R311 | R: 9.1K ¼W 5% comp | 01121 | CB |
| R312 | R: 4.7K ¼W 10% comp | 01121 | CB |
| R313 | R: 11.0K 1/8W 1% mf | 06486 | CEATO |
| R314 | R: 17.8K 1/8 W 1% mf | 06486 | CEATO |
| R315 | R: 33.2K 1/8W 1% mf | 06486 | CEATO |
| R316 | R: 470 ¼W 10% comp | 01121 | CB |
| R317 | R: 390 ¼W 10% comp | 01121 | CB |
| R318 | R: 562 1/8W 1% mf | 06486 | CEATO |
| R319 | R: 100 1/8W 1% mf | 06486 | CEATO |
| R320 | R: 18K ¼W 10% comp | 01121 | CB |
| R321 | R: 33K ¼W 10% comp | 01121 | CB |
| R322 | R: 470 ¼W 10% comp | 01121 | CB |
| R323 | R: 560 ¼W 10% comp | 01121 | CB |
| R234 | R: 68 ¼W 10% comp | 01121 | CB |
| R325 | R: 500 10% ww var | 80294 | 3007P-1-501 |
| R326 | R: 68 ¼W 10% comp | 01121 | CB |
| R327 | R: 560 ¼W 10% comp | 01121 | CN |
| R328 | R: 5.6K ¼W 10% comp | 01121 | CB |
| R329 and R330 | R: 33.2 1/8W 1% mf | 06486 | CEATO |
| R331 | R: 820 ¼W 10% comp | 01121 | CB |
| R332 | R: 5.6K ¼W 10% comp | 01121 | CB |
| R333 | R: 820 ¼W 10% comp | 01121 | CB |
| R334 | R: 1.5K ¼W 10% comp | 01121 | CB |
| R335 | R: 2.2K ¼W 10% comp | 01121 | CB |
| R336 | R: 1K ¼W 10% comp | 01121 | CB |
| R337 | R: 18K ¼W 10% comp | 01121 | CB |
| R338 | R: 2.2K ¼W 10% comp | 02121 | CB |
| R339 | R: 1K ¼W 10% comp | 01121 | CB |
| R340 | R: 18K ¼W 10% comp | 01121 | CB |
| R341 and R342 | R: 2.2K ¼W 10% comp | 01121 | CB |
| R343 and R344 | R: 10K ¼W 10% comp | 01121 | CB |
| R345 | R: 1K ¼W 10% comp | 01121 | CB |
| R346 | R: 4.7K ¼W 10% comp | 01121 | CB |
| R347 | R: 470 ¼W 10% comp | 01121 | CB |
| R348 and R349 | R: 10K ¼W 10% comp | 01121 | CB |
| R350 | R: 10 ¼W 10% comp | 01121 | CB |
| R351 | R: 732 1/8W 1% mf | 06486 | CEATO |
| R352 | R: 28.0 1/8W 1% mf | 06486 | CEATO |
| R353 | R: 365 1/8W 1% mf | 06486 | CEATO |
| R354 | R: 28.0 1/8W 1% mf | 06486 | CEATO |
| R355 | R: 365 1/8W 1% mf | 06486 | CEATO |
| R366 | R: 28.0 1/8W 1% mf | 06486 | CEATO |
| R357 | R: 365 1/8W 1% mf | 06486 | CEATO |
| R358 | R: 28.0 1% mf | 06486 | CEATO |
| R359 | R: 365 1/8W 1% mf | 06486 | CEATO |

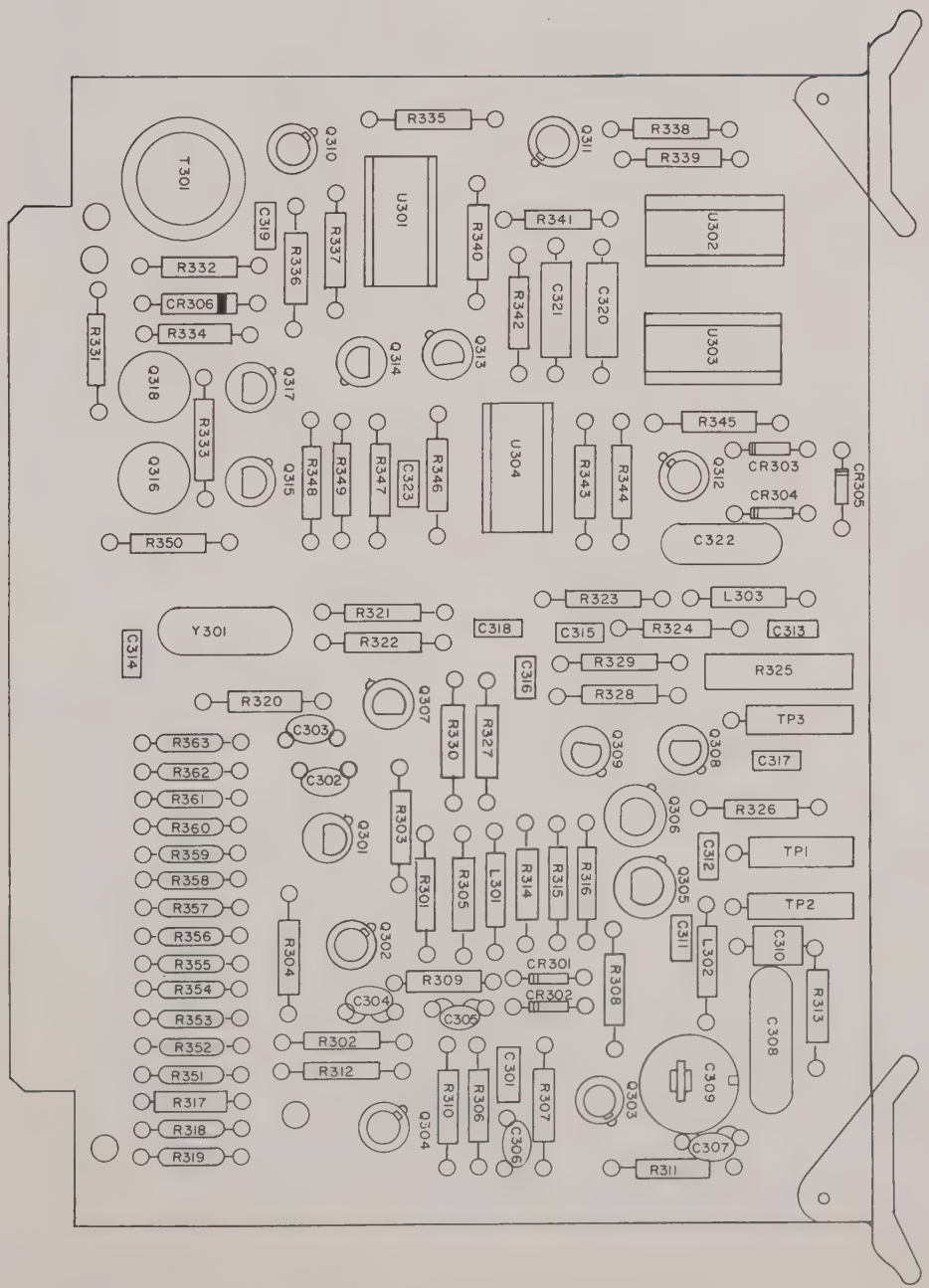



Figure 6-4 Compnent Location E95585

PC Board E95585

| Ref Desig. | Description | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| R360 | R: 28.0 1/8W 1% mf | 06486 | CEATO |
| R361 | R: 365 1/8W 1% mf | 06486 | CEATO |
| R362 | R: 28.0 1/8W 1% mf | 06486 | CEATO |
| R363 | R: 88.7 1/8W 1% mf | 06486 | CEATO |
| C301 | C: 22 6V 10% tant | 05397 | K22W6K |
| C302 | C: 82pF 1KV 10% cer | 71590 | DD-820 |
| C303 | C: 68pF 1KV 10% cer | 71590 | DD-680 |
| C304 | C: 150pF 10% cer | 71590 | DD-151 |
| C305 thru C307 | C: 15pF 1KV 10% cer | 71590 | DD-150 |
| C308 | C: 0.0022 100V 10% film | 13606 | 225P |
| C309 | C: 10-75pF cer var | 72982 | |
| C310 | C: 390pF 1KV 10% cer | 71590 | DD-391 |
| C311 | D: 0.1 50V 10% tant | 05397 | KR1W50K |
| C312 | C: 1.0 35V 10% tant | 05397 | K1RW35K |
| C313 | C: 22 6V 10% tant | 05397 | K22W6K |
| C314 | C: 22 6V 10% tant | 05397 | K22W6K |
| C315 thru C317 | C: 1.0 35V 10% tant | 05397 | K1RW35K |
| C318 and C319 | C: 10 10V 10% tant | 05397 | K10W10K |
| C320 and C321 | C: 30pF 500V 5% sm | 72136 | CM-15E-300J |
| C322 | C: 0.001 100V 10% film | 13606 | 225P |
| C323 | C: 22 6V 10% tant | 05397 | K22W6K |
| CR301 thru CR305 | Diode silicon | 12065 | 1N4148 |
| CR306 | Diode hot carrier | 28480 | 5082-2800 |
| Q301 | Transistor silicon NPN | 15873 | 2N3903 |
| Q302 thru Q304 | Transistor silicon NPN | 24446 | 2N706A |
| Q305 | Transistor silicon NPN | 15873 | MPS 6515 |
| Q306 and Q307 | Transistor silicon NPN | 15873 | 2N3903 |
| Q308 | Transistor silicon PNP | 15873 | 2N3905 |
| Q309 | Transistor silicon NPN | 15873 | 2N3903 |
| Q310 thru Q312 | Transistor silicon NPN | 24446 | 2N706A |
| Q313 thru Q315 | Transistor silicon NPN | 15873 | 2N3903 |
| Q316 | Transistor silicon NPN | 49671 | 2N2102 |
| Q317 | Transistor silicon NPN | 15873 | 2N3903 |
| Q318 | Transistor silicon NPN | 49671 | 2N2102 |
| L301 | Inductor molded 47μH 5% | 29525 | WEE-47 |
| L302 | Inductor molded 100μH 2½% | 29525 | WEE-100 |
| U301 | Integrated circuit dual 3-input OR GATE | 18324 | SP333A |
| U302 and U303 | Integrated circuit quad 2-input NOR GATE | 18324 | SN7402N |
| U304 | Integrated circuit 2-input NOR GATE | 18324 | SP380A |
| T301 | Transformer pulse 1:1:1:1 | 18043 | |
| TP1, TP2, TP3 | Test jack rt angle | 17117 | 4879-125-9 |
| Y301 | Crystal 1.54000 MHz | 79066 | VR-6 |

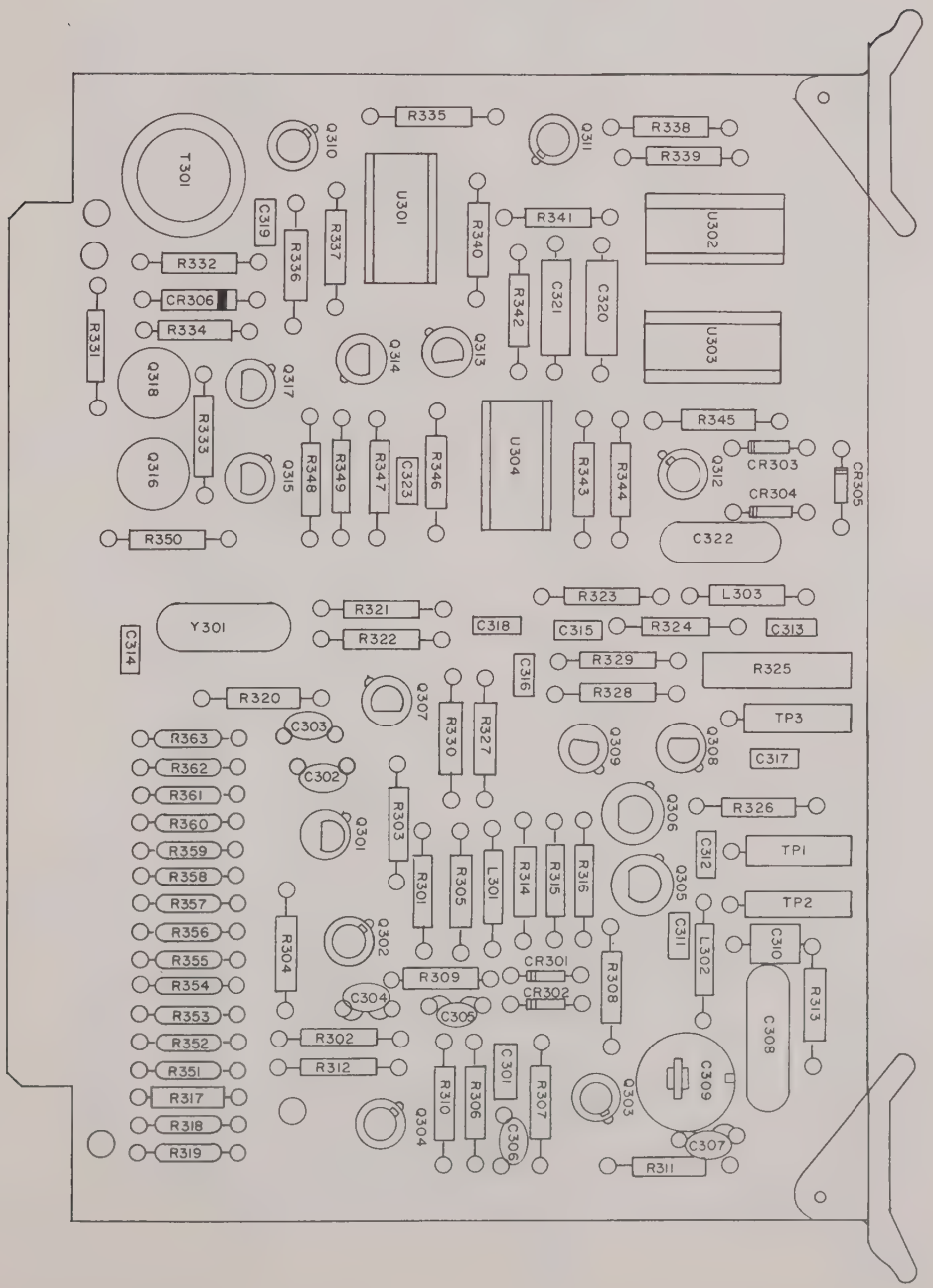



Figure 6-5 Component Location E95585

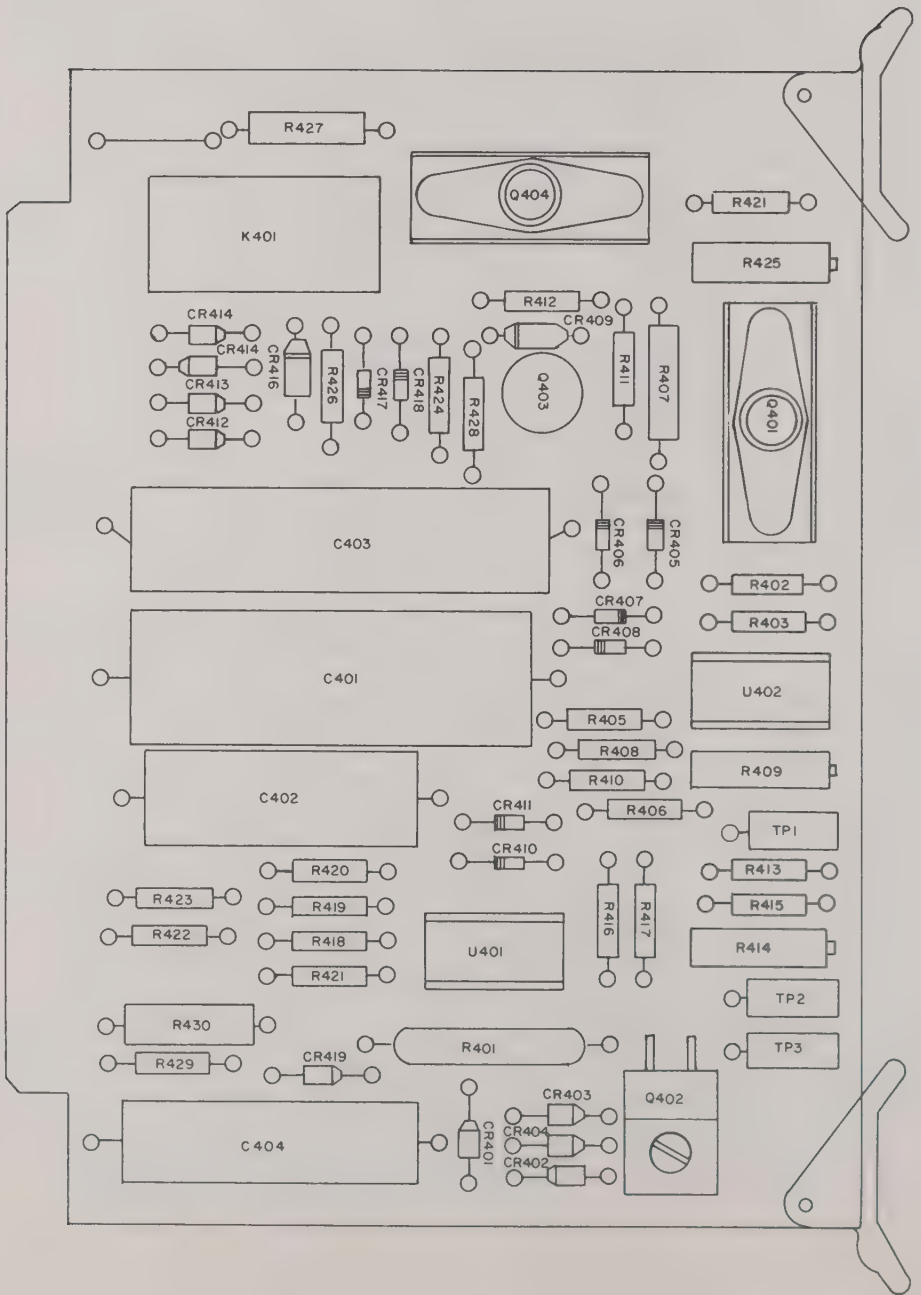



Figure 6-6 Component Location E95586

PC Board E95586

| Ref Desig. | Description | Manufacturer (FSCM Code Bo.) | Part Number |
|---|---|---|---|
| R401 | R: 5.0 5W 10% ww | 12697 | VC5E |
| R402 | R: 2.7K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R403 | R: 100 $\frac{1}{4}$W 10% comp | 01121 | CB |
| R404 | R: 3.3K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R405 | R: 330 $\frac{1}{4}$W 10% comp | 01121 | CB |
| R406 | R: 1K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R407 | R: 1.8 1W 5% comp | 06486 | BWH |
| R408 | R: 2.7K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R409 | R: 2K 10% ww var | 80294 | 3007P-1-202 |
| R410 | R: 1oK $\frac{1}{4}$W 10% comp | 01121 | CB |
| R411 | R: 6.8K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R412 | R: 100 $\frac{1}{4}$W 10% comp | 01121 | CB |
| R413 | R: 15K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R414 | R: 2K 10% ww var | 80294 | 3007P-1-202 |
| R415 | R: 10K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R416 and R417 | R: 1.5K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R418 | R: 100 $\frac{1}{4}$W 10%ccomp | 01121 | CB |
| R419 and R420 | R: 1K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R421 | R: 3.3K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R422 and R423 | R: 10K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R424 | R: 270 $\frac{1}{4}$W 10% comp | 01121 | CB |
| R425 | R: 1K 10% ww var | 08294 | 3007p-1-102 |
| R426 | R: 1K $\frac{1}{4}$W 10% comp | 01121 | CB |
| R427 | R: 20 5% 3W ww | 80294 | VC3D |
| R428 | R: 120 $\frac{1}{4}$W 10% comp | 01121 | CB |
| R429 | R: 1K $\frac{1}{2}$W 10% comp | 01121 | CB |
| R430 | R: 120K 1W 10% comp | 01121 | CB |
| C401 | C: 100 25V 10% elect | 13606 | 39D108 |
| C402 | C: 200 20V 10% elect | 09653 | APD-115 |
| C403 | C: 200 50V 10% elect | 09653 | FPA-209-SJ0 |
| C404 | C: 1.0 200V 10% film | 13606 | 431P |
| CR401 thru CR404 | Diode silicon | 01295 | 1N2069 |
| CR405 thru CR408 | Diode silicon | 12065 | 1N4148 |
| CR409 | Diode zener 6.2V 5% | 12054 | 1N709A |
| CR410 and CR411 | Diode silicon | 12065 | 1N4148 |
| CR412 thru CR415 | Diode silicon | 01295 | 1N2069 |
| CR416 | Diode zener 6.2V 5% | 12954 | 1N709A |
| CR417 and CR418 | Diode silicon | 12065 | 1N4148 |
| CR419 | Diode silicon | 01295 | 1N2069 |
| Q401 | Transistor silicon NPN | 49671 | 40372 |
| Q402 | Transistor silicon PNP | 01295 | T1P30A |
| Q403 | Transistor silicon NPN | 49671 | 2N2102 |
| Q404 | Transistor silicon NPN | 49671 | 40372 |
| U401 and U402 | Integrated circuit transistor array | 49671 | CA3046 |
| K1 | Relay 700Ω 4C 24V | 78277 | 62R4-246 |
| TP1, TP2, TP3 | Test jack rt angle | 17117 | 4879-125-9 |

PC Board E95579

| Ref Desig. | Description | Manufacturer (FSCM Code No. ) | Part Number |
|---|---|---|---|
| R501 and R502 | R: 100Ω 1/8W 1% mf | 06486 | CEATO |
| R503 | R: 12.7Ω 1/8W 1% mf | 06486 | CEATO |
| R504 | R: 665Ω 1/8W 1% mf | 06486 | CEATO |
| R505 and R506 | R: 100Ω 1/8W 1% mf | 06486 | CEATO |
| C501A | C: 0.0027 100V 2% sm | 72136 | DM-20-272G |
| C501B | C: 18pF 1KB 10% cer | 71590 | DD-180 |
| L501 | Inductor molded 27μH 2.5% | 29525 | WEE-27 |
| K3 | Relay 24V 3C reed | 04221 | 172-200EB1 |
| S1 | Switch assy, P.B. | 71590 | S-7002-012 |

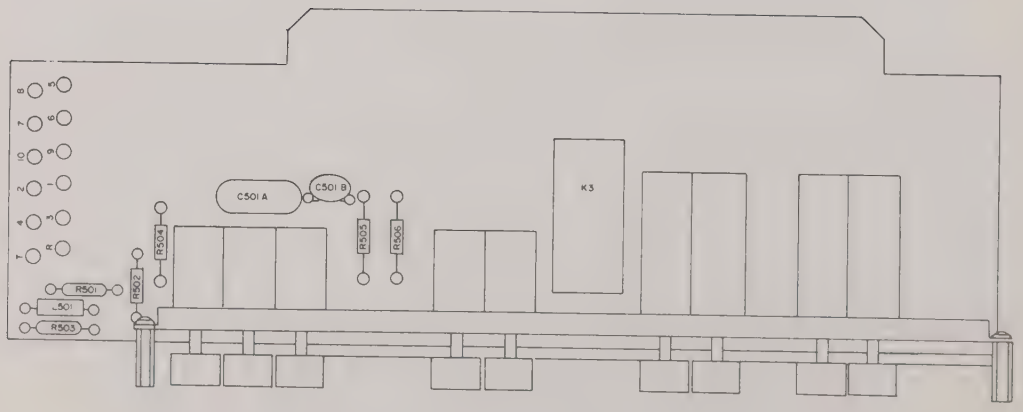



Figure 6-7 Component Location E95579

PC Board E95581

| Ref Desig. | Description | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| R701 | R: 100Ω 1/8W 1% mf | 06486 | CEATO |
| R702 | R: 301Ω 1/8W 1% mf | 06486 | CEATO |
| R703 | R: 75.0Ω 1/8W 1% mf | 06486 | CEATO |
| R704 | R: 301Ω 1/8W 1% mf | 06486 | CEATO |
| R705 | R: 261Ω 1/8W 1% mf | 06486 | CEATO |
| R706 | R: 86.6Ω 1/8W 1% mf | 06486 | CEATO |
| R707 | R: 261Ω 1/8W 1% mf | 06486 | CEATO |
| R708 | R: 232Ω 1/8W 1% mf | 06486 | CEATO |
| R709 | R: 105Ω 1/8W 1% mf | 06486 | CEATO |
| R710 | R: 232Ω 1/8W 1% mf | 06486 | CEATO |
| R711 | R: 210Ω 1/8W 1% mf | 06486 | CEATO |
| R712 | R: 124Ω 1/8W 1% mf | 06486 | CEATO |
| R713 | R: 210Ω 1/8W 1% mf | 06386 | CEATO |
| R714 | R: 191Ω 1/8W 1% mf | 06386 | CEATO |
| R715 | R: 143Ω 1/8W 1% mf | 06486 | CEATO |
| R716 | R: 191Ω 1/8W 1% mf | 06486 | CEATO |
| R717 | R: 365Ω 1/8W 1% mf | 06486 | CEATO |
| R718 | R: 60.4Ω 1/8W 1% mf | 06486 | CEATO |
| R719 | R: 365Ω 1/8W 1% mf | 06486 | CEATO |
| R720 | R: 3480 1/8W 1% mf | 06486 | CEATO |
| R721 | R: 5.6Ω 1/8W 1% mf | 94322 | SA1G |
| R722 | R: 3480 1/8W 1% mf | 06486 | CEATO |
| S3 | Switch assy P.B. | 71590 | S-7002-016 |

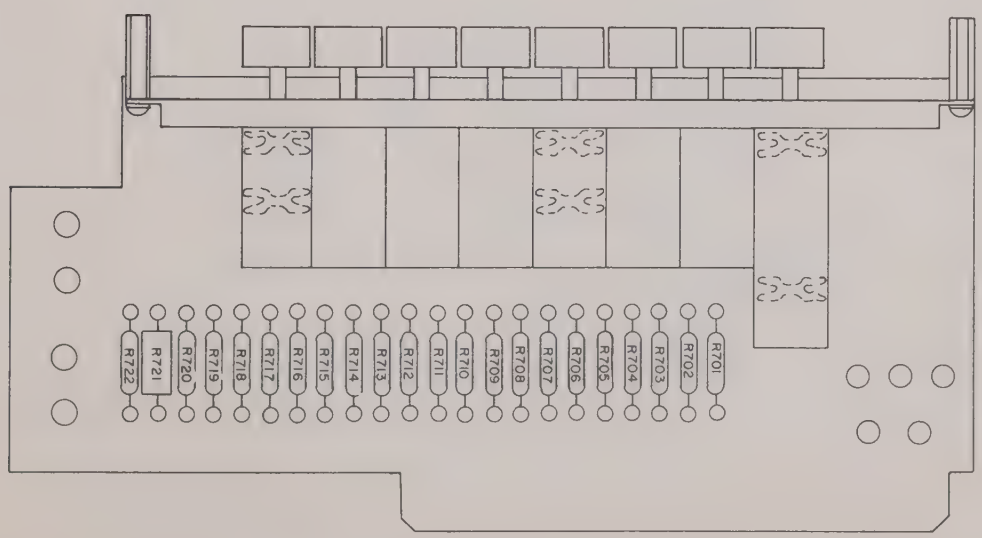



Figure 6-8 Component Location E95581

PC Board E07-002-00-018

| Ref Desig. | Description | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| R801 | R: 10Ω 2W 10% ww | 13606 | 240E1001 |
| R802 | R: 4020 1/8W 1% mf | 06486 | CEATO |
| R803 | R: 31.6K 1/8W 1% mf | 06486 | CEATO |
| R804 | R: 20Ω 3W 5% ww | 13606 | 242E2005 |
| R805 | R: 31.6K 1/8W 1% mf | 06486 | CEATO |
| R806 | R: 250Ω comp var with CC switch | 71450 | UA2186 |
| R807 | R: 1K comp var | 71450 | UA2185 |
| R808 | R: 18.2K 1/8W 1% mf | 06486 | CEATO |
| S4 | Switch assy P.B. | 71590 | 5-7002-018 |

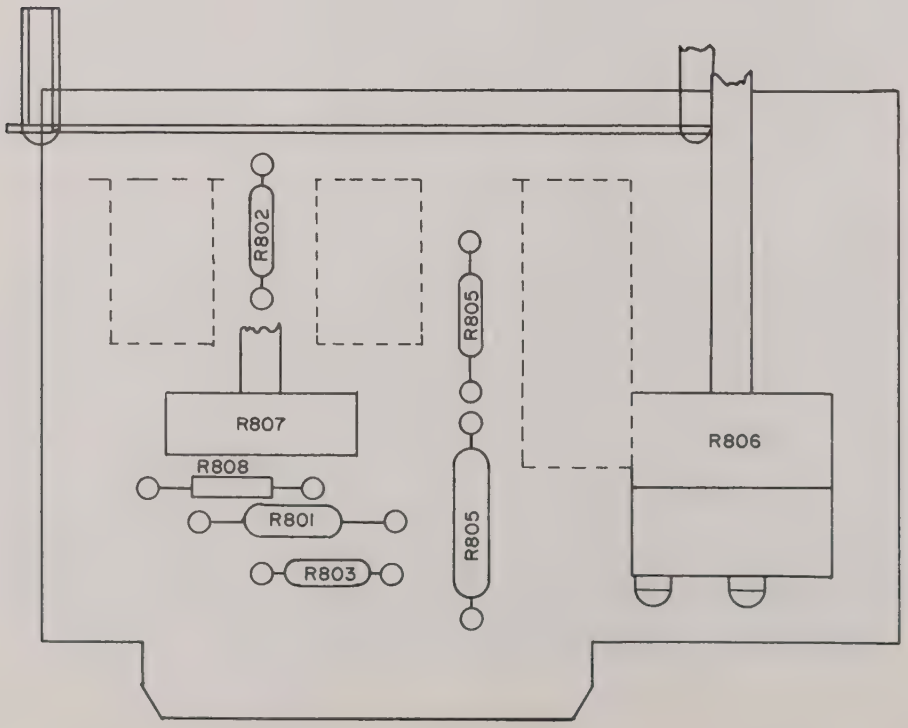



Fig. 6-9 Component Location E07-002-00-018

PC Board E95578

| Ref Desig. | Description | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| R901 and R902 | R: 100K $\frac{1}{4}$W 10% | 01121 | CB |
| R903 | R: 1M $\frac{1}{4}$W 10% | 01121 | CB |
| R904 | R: 10K $\frac{1}{4}$W 10% | 01121 | CB |
| R905 | R: 22K $\frac{1}{4}$W 10% | 01121 | CB |
| C901 | C: 0.1 50V 10% tant | 05397 | KR1W50K |
| CR901 thru CR904 | Diode silicon | 12065 | 1N4148 |
| CR905 | Diode zener 6.2V 5% | 12954 | 1N709A |
| Q901 | Transistor fet, N channel | 15873 | 2N5457 |
| Q902 | Transistor silicon PNP | 15873 | MPS 6519 |
| K4 | Relay reed 6V 1C | 04221 | 172-100-BA2 |

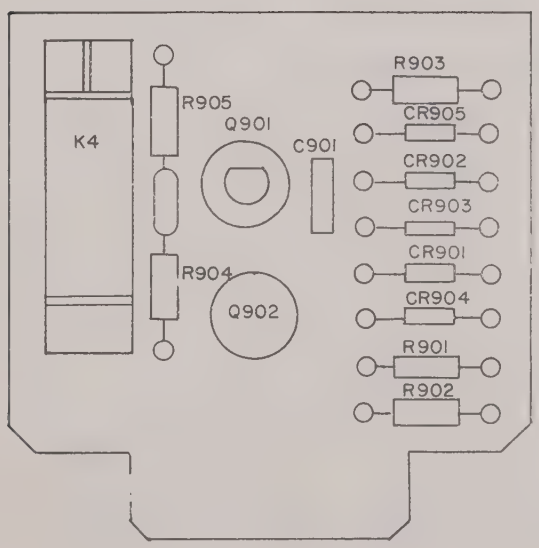



Figure 6-10 Component Location E95578

| Ref Desig. | Description | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| J1 | Connector flange | 02660 | 165-12 |
| J2 | Jack phone | 28389 | 12B |
| J3A | Binding post red | 17117 | 5595-175-2 |
| J3B | Binding post blk | 17117 | 5595-175-0 |
| J4A | Binding post red | 17117 | 5595-175-2 |
| J4B | Binding post blk | 17117 | 5595-175-0 |
| J5 | Receptacle ac | 82389 | AC3G |
| S5 | Switch P.B. illum. | 72619 | 183-0301-1475-604 |
| S6 | Switch P.B. illum. | 72169 | 913-1433 |
| S7 | Switch toggle 3 P2T | 09353 | 7301 |
| S8 | Switch P.B. | 81073 | 46-101-B |
| XF | Fuseholder | 71400 | HKP |
| F1 | Fuse | 71400 | 3AG$\frac{1}{2}$AMP |
| M1 | Meter model 204TB | 06555 | 6978-00 |
| A1 | Counter mech | 75523 | RG152E-12V |
| CR1 | Diode rectifier | 01295 | 1N2069 |
| R1 | R: 100K $\frac{1}{4}$W 10% comp | 01121 | CB |
| C1 and C2 | C: 470pF 1KV 10% cer | 71590 | CE471 |
| C3 | C: 200V film | 13606 | 431P |
| L1 and L2 | Inductor molded 100μH 10% | 76493 | 9350-08 |
| DS1 | Lamp 6.0V2 mA T-1$\frac{3}{4}$ | 71744 | 328 |
| T1 | Transformer Power | 17538 | NEC-1 |

PC Bd. E95580

| Ref Desig. | Description | Manufacturer (FSCM Code No.) | Part Number |
|---|---|---|---|
| S2 | Switch assy P.B. | 71590 | S-7002-013 |
| K2 | Relay reed 24V 1C | 02289 | 3520-1CC-24 |

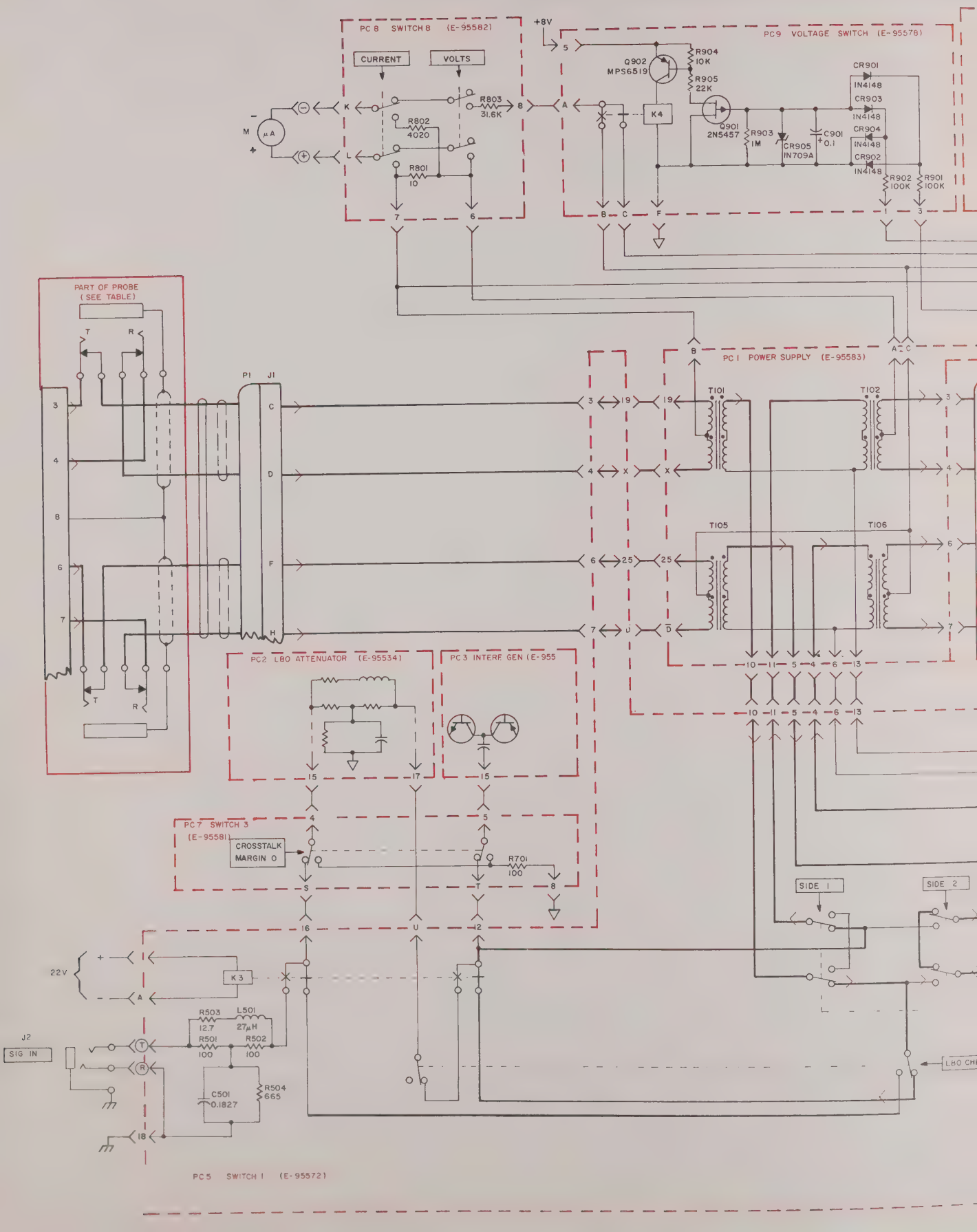
# SECTION 7

## SCHEMATIC DIAGRAMS

7.1 INTRODUCTION. The following pages contain the schematic diagrams for the Model 7002.

NOTES:

1. Resistance and capacitance expressed in ohms and microfarads unless noted.
2. Voltage measurements and waveforms referred to circuit common ( ⏚ ) unless noted.
3. Circuit interconnections between pc boards and the front panel are made through the harness board.


PC 8 SWITCH 8 (E-95582)
CURRENT
VOLTS
R803 31.6K
R802 4020
R801 10
M
μA
PC 9 VOLTAGE SWITCH (E-95578)
+8V
Q902 MPS6519
R904 10K
R905 22K
K4
Q901 2N5457
R903 1M
CR905 IN709A
C901 0.1
CR901 IN4148
CR903 IN4148
CR904 IN4148
CR902 IN4148
R902 100K
R901 100K
PART OF PROBE (SEE TABLE)
P1 J1
PC 1 POWER SUPPLY (E-95583)
T101
T102
T105
T106
PC2 LBO ATTENUATOR (E-95534)
PC 3 INTERF GEN (E-955
PC 7 SWITCH 3 (E-95581)
CROSSTALK MARGIN 0
R701 100
SIDE 1
SIDE 2
22V
K3
R503 12.7
L501 27μH
R501 100
R502 100
C501 0.1827
R504 665
J2
SIG IN
LBO CH
PC 5 SWITCH 1 (E-95572)

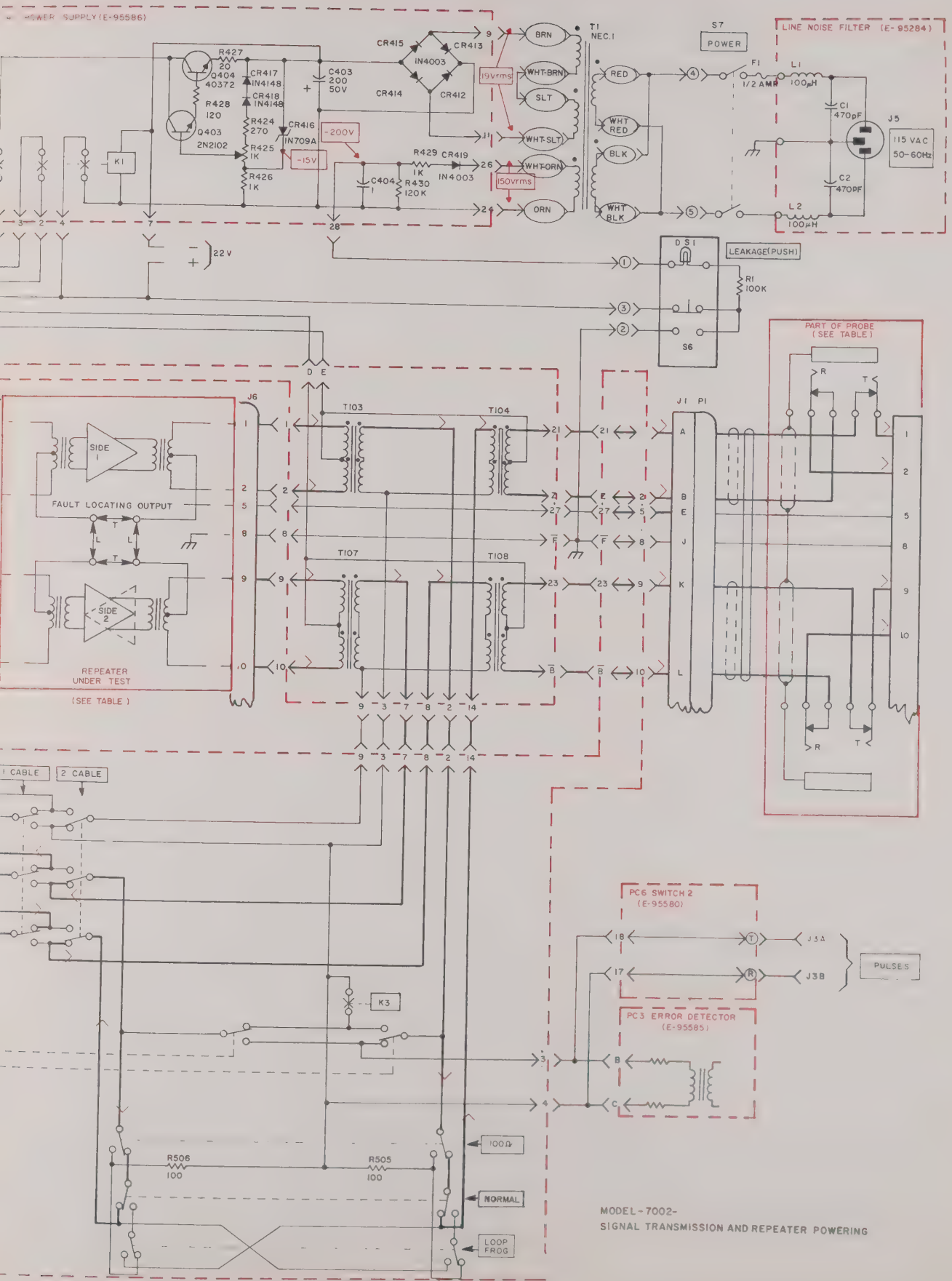
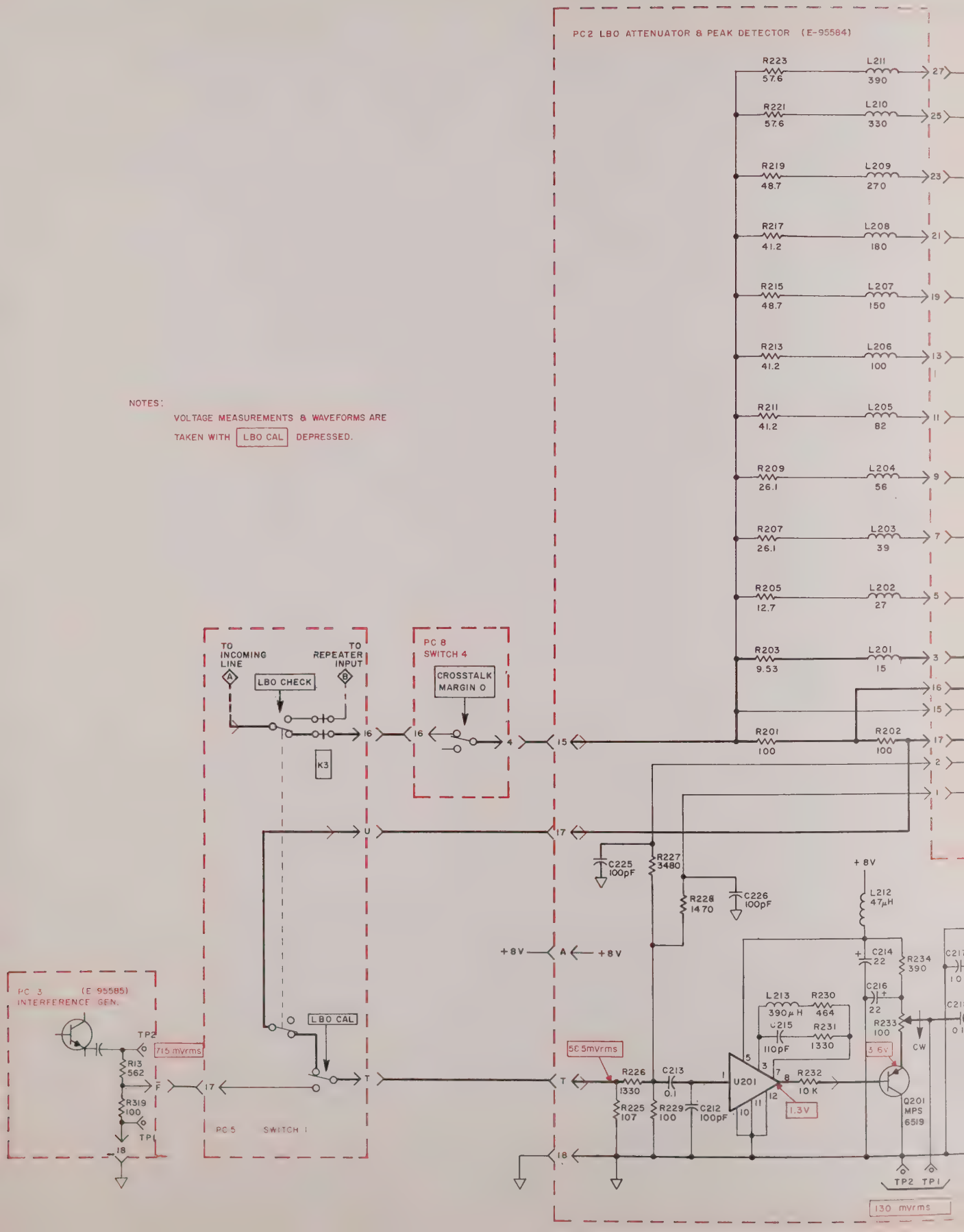



Figure 7-1 Model 7002 Overall Diagram


PC2 LBO ATTENUATOR & PEAK DETECTOR (E-95584)
R223 57.6
L211 390
R221 57.6
L210 330
R219 48.7
L209 270
R217 41.2
L208 180
R215 48.7
L207 150
R213 41.2
L206 100
R211 41.2
L205 82
R209 26.1
L204 56
R207 26.1
L203 39
R205 12.7
L202 27
R203 9.53
L201 15
R201 100
R202 100
NOTES:
VOLTAGE MEASUREMENTS & WAVEFORMS ARE TAKEN WITH LBO CAL DEPRESSED.
TO INCOMING LINE
TO REPEATER INPUT
LBO CHECK
K3
PC 8 SWITCH 4
CROSSTALK MARGIN 0
PC 3 (E 95585) INTERFERENCE GEN.
TP2
715 mVrms
R13 562
R319 100
TP1
PC 5 SWITCH 1
LBO CAL
C225 100pF
R227 3480
R228 1470
C226 100pF
+8V
L212 47μH
C214 22
R234 390
C216 22
L213 390μH
R230 464
C215 110pF
R231 1330
R233 100
CW
3.6V
Q201 MPS 6519
505mVrms
R226 1330
C213 0.1
U201
R232 10K
1.3V
R225 107
R229 100
C212 100pF
TP2 TP1
130 mVrms

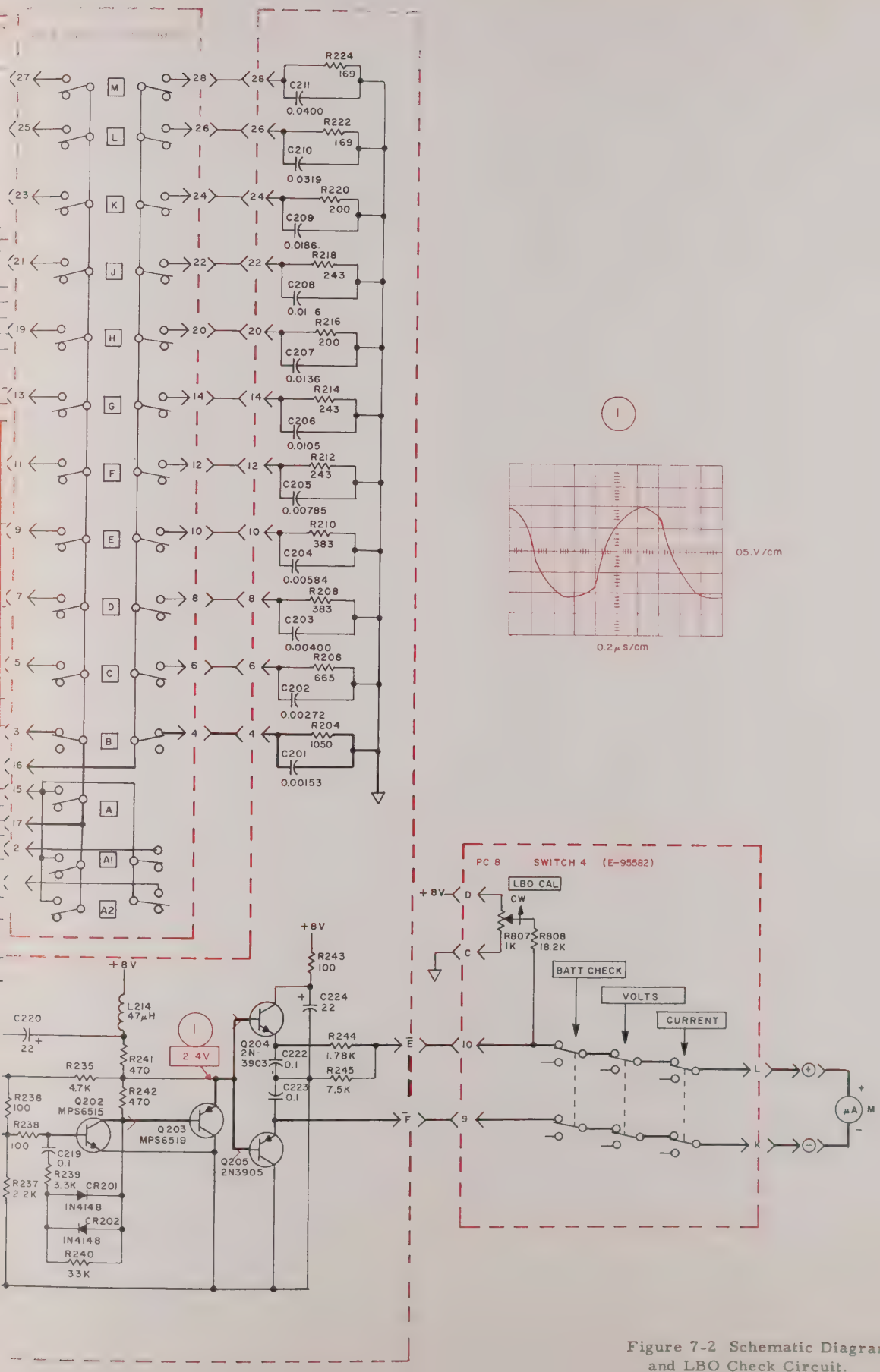
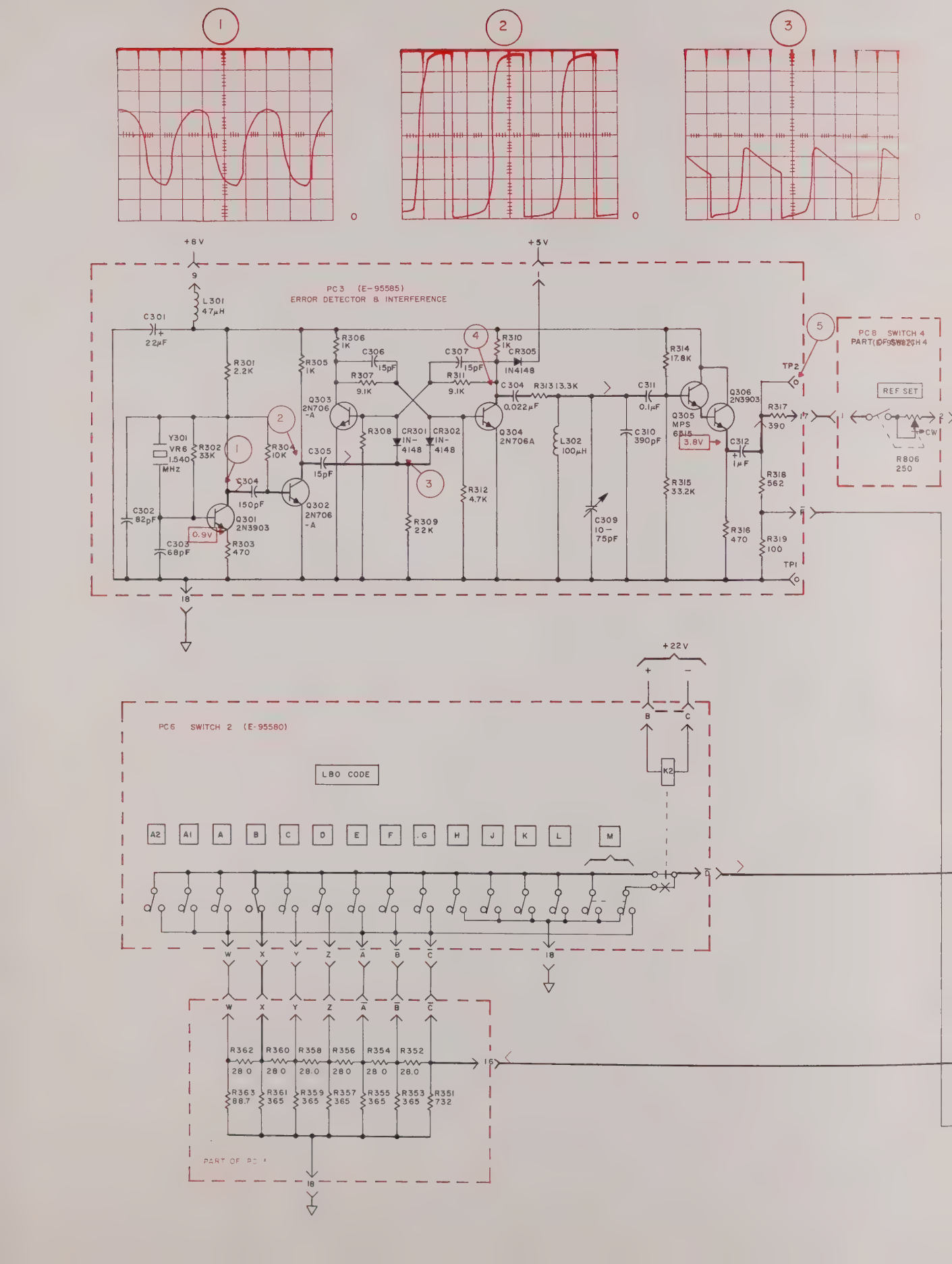



Figure 7-2 Schematic Diagram LBO Attenuator and LBO Check Circuit.


1
2
3
+8V
+5V
PC3 (E-95585)
ERROR DETECTOR & INTERFERENCE
L301 47μH
C301 22μF
R301 2.2K
R305 1K
R306 1K
C306 15pF
R307 9.1K
C307 15pF
R311 9.1K
R310 1K
CR305 IN4148
C304 0.022μF
R313 13.3K
C311 0.1μF
R314 17.8K
Q306 2N3903
TP2
PC8 SWITCH 4
REF SET
R806 250
R317 390
Q303 2N706 -A
R308
CR301 IN-4148
CR302 IN-4148
Q304 2N706A
L302 100μH
C310 390pF
Q305 MPS 6515
3.8V
C312 1μF
Y301 VR6 1.540 MHz
R302 33K
R304 10K
C305 15pF
C304 150pF
Q302 2N706 -A
R312 4.7K
R315 33.2K
R318 562
C302 82pF
Q301 2N3903
0.9V
C303 68pF
R303 470
R309 22K
C309 10-75pF
R316 470
R319 100
TP1
+22V
PC6 SWITCH 2 (E-95580)
LBO CODE
A2
A1
A
B
C
D
E
F
G
H
J
K
L
M
K2
W
X
Y
Z
A
B
C
R362 28.0
R360 28.0
R358 28.0
R356 28.0
R354 28.0
R352 28.0
R363 88.7
R361 365
R359 365
R357 365
R355 365
R353 365
R351 732
PART OF PC 4

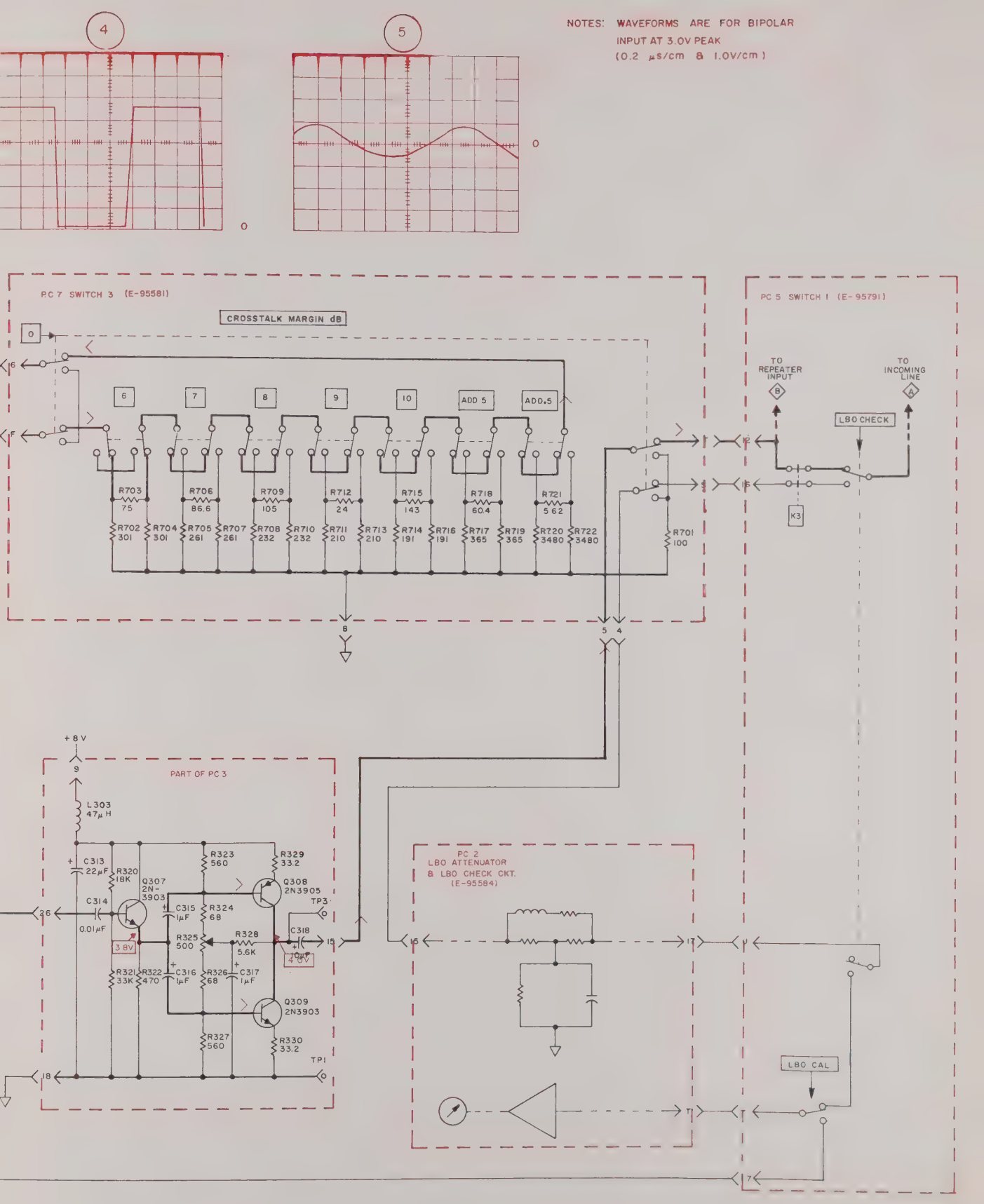
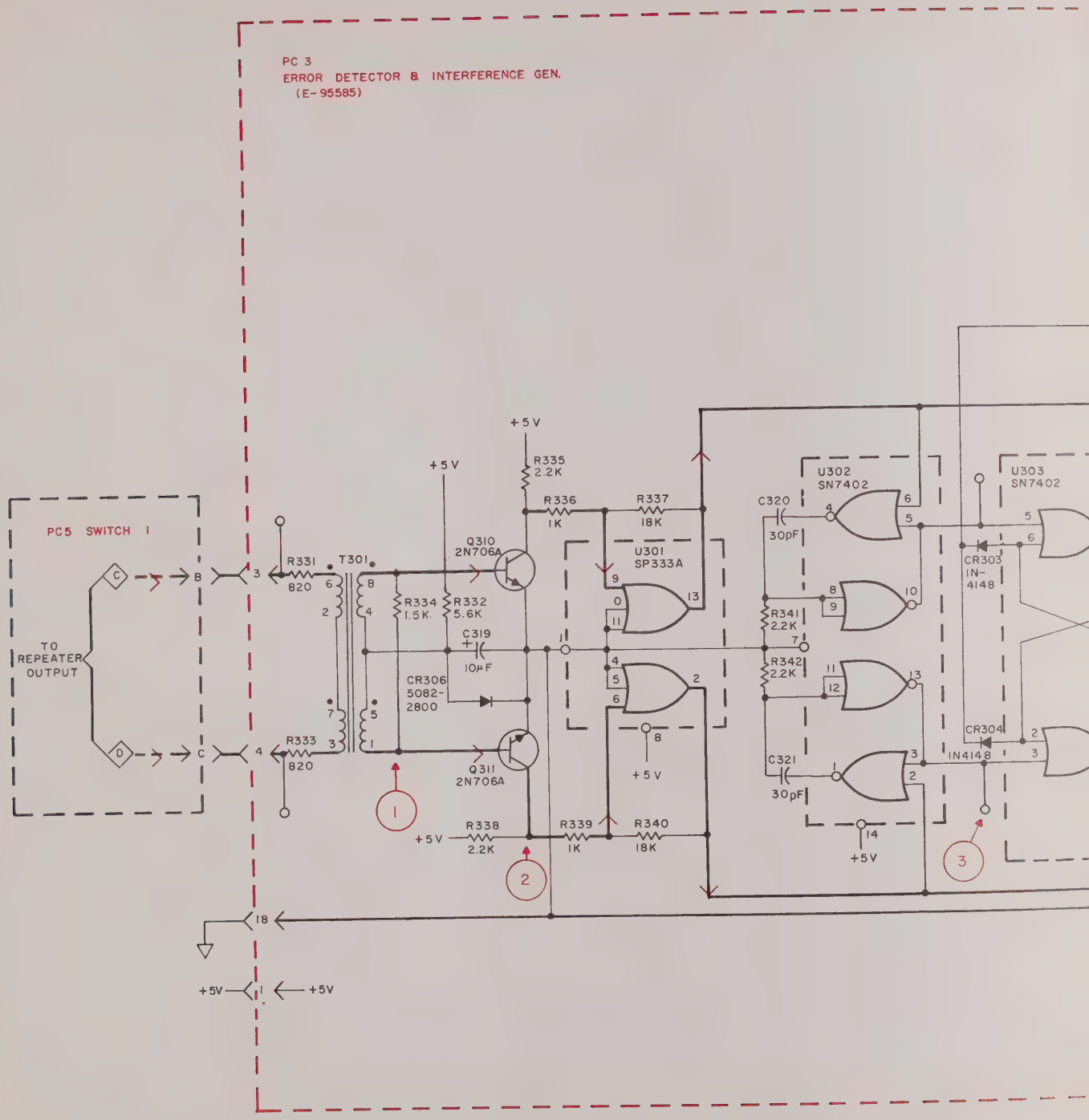



Figure 7-3 Schematic Diagram Crosstalk Margin Test Circuit.


PC 3
ERROR DETECTOR & INTERFERENCE GEN.
(E-95585)
PC5 SWITCH 1
TO REPEATER OUTPUT
C
D
B
C
3
4
R331
820
R333
820
T301
R334
1.5K.
R332
5.6K
Q310
2N706A
Q311
2N706A
+5V
R335
2.2K
R336
1K
R337
18K
C319
10μF
CR306
5082-
2800
U301
SP333A
R338
2.2K
R339
1K
R340
18K
U302
SN7402
U303
SN7402
C320
30pF
C321
30pF
R341
2.2K
R342
2.2K
CR303
IN-
4148
CR304
IN4148
18
+5V
1
2
3

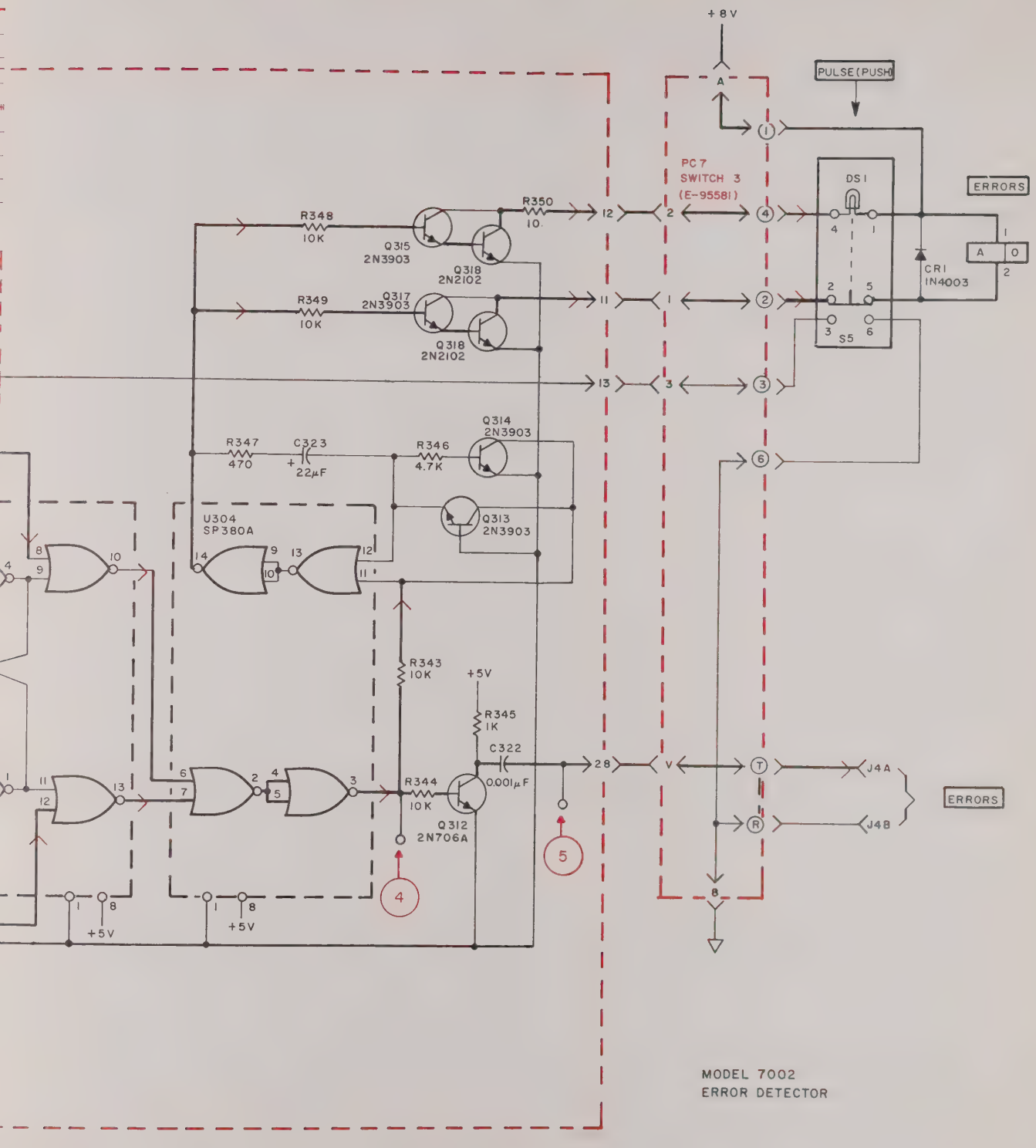
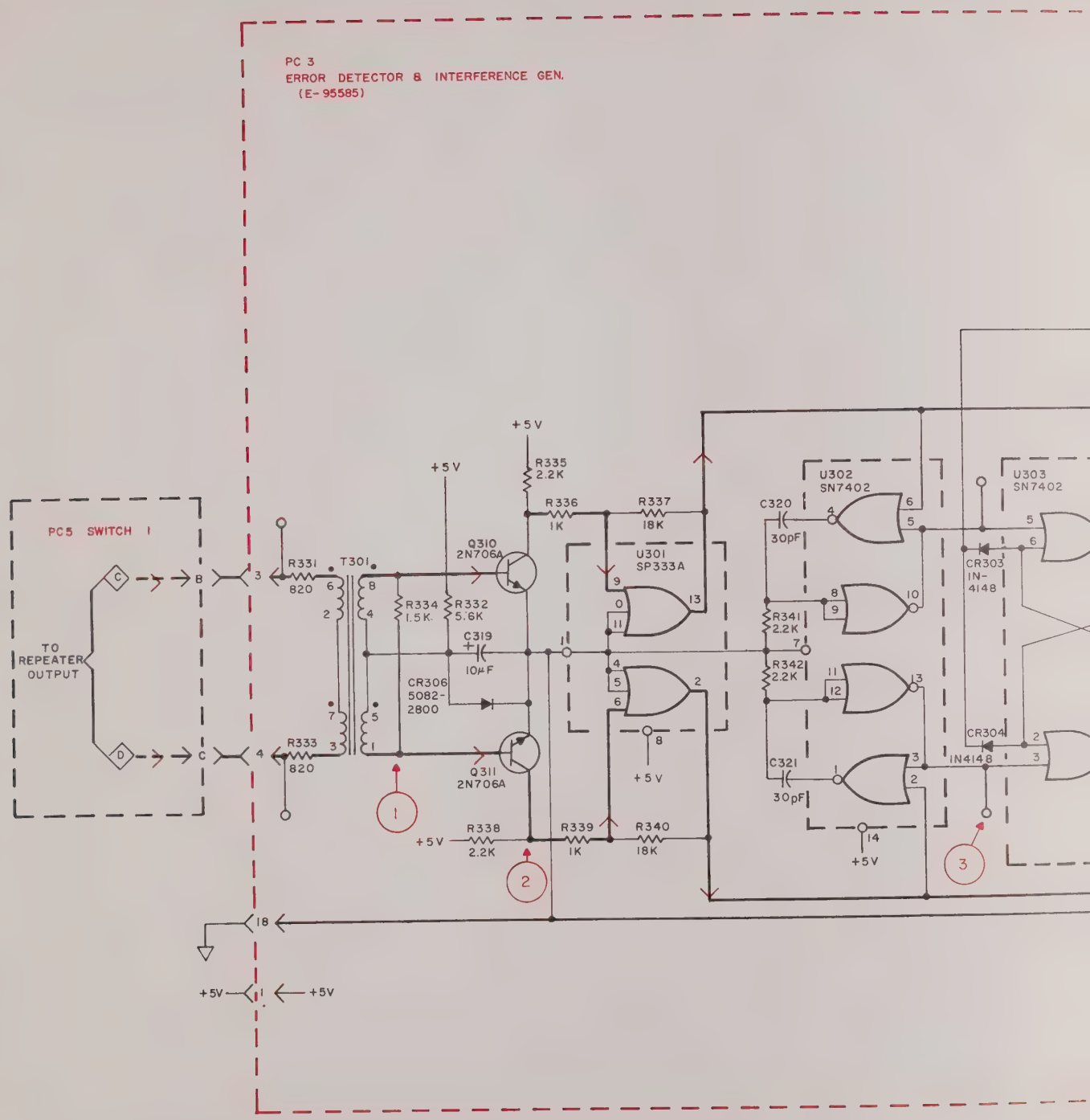



Figure 7-4 Schematic Diagram Error Detector.


PC 3
ERROR DETECTOR & INTERFERENCE GEN.
(E-95585)
PC5 SWITCH 1
TO REPEATER OUTPUT
C
D
B
C
3
4
R331
820
R333
820
T301
R334
1.5K
R332
5.6K
Q310
2N706A
Q311
2N706A
C319
10μF
CR306
5082-
2800
+5V
R335
2.2K
R336
1K
R337
18K
R338
2.2K
R339
1K
R340
18K
U301
SP333A
U302
SN7402
U303
SN7402
C320
30pF
C321
30pF
R341
2.2K
R342
2.2K
CR303
IN-
4148
CR304
IN4148
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2
3
18
+5V
+5V

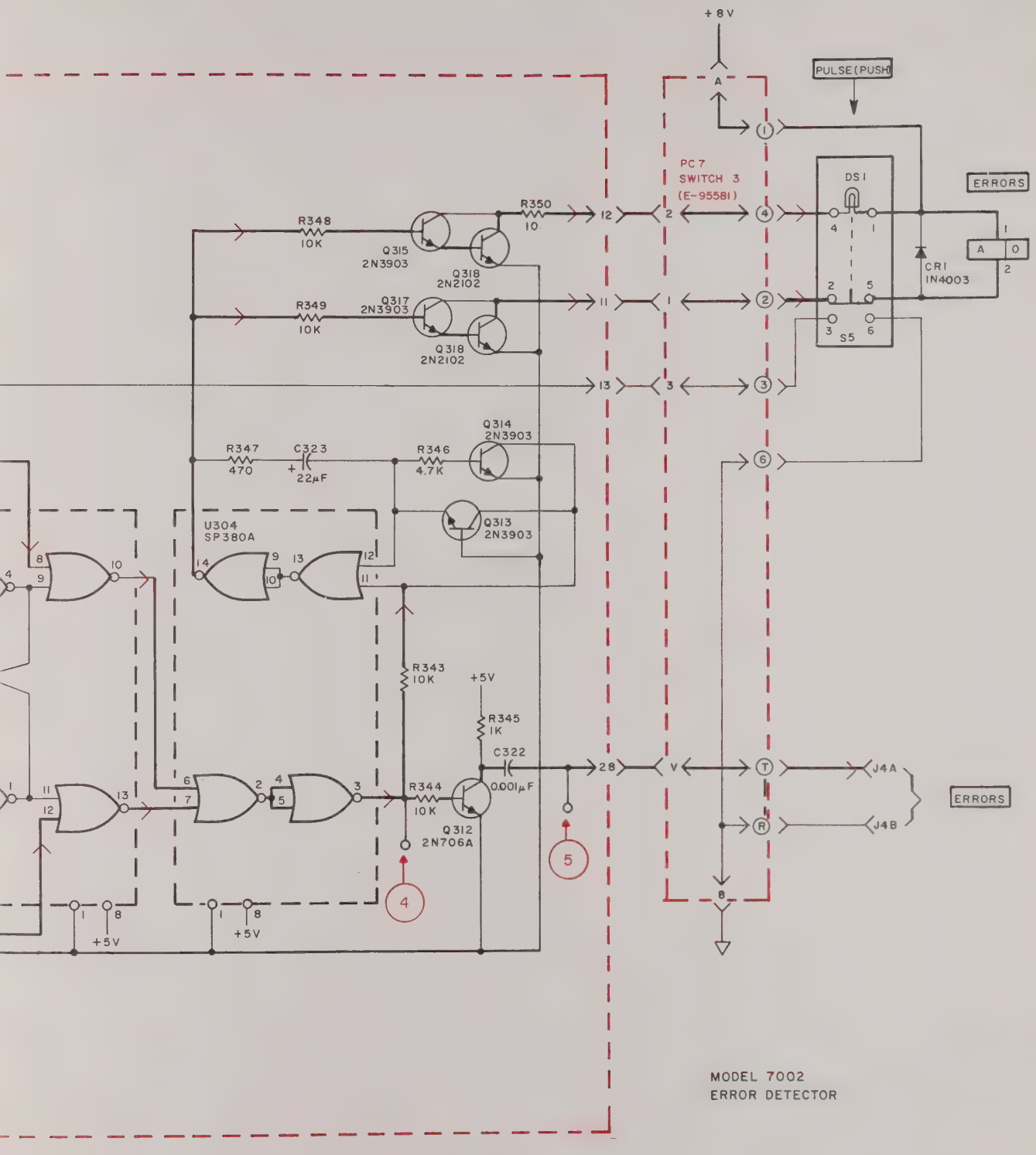
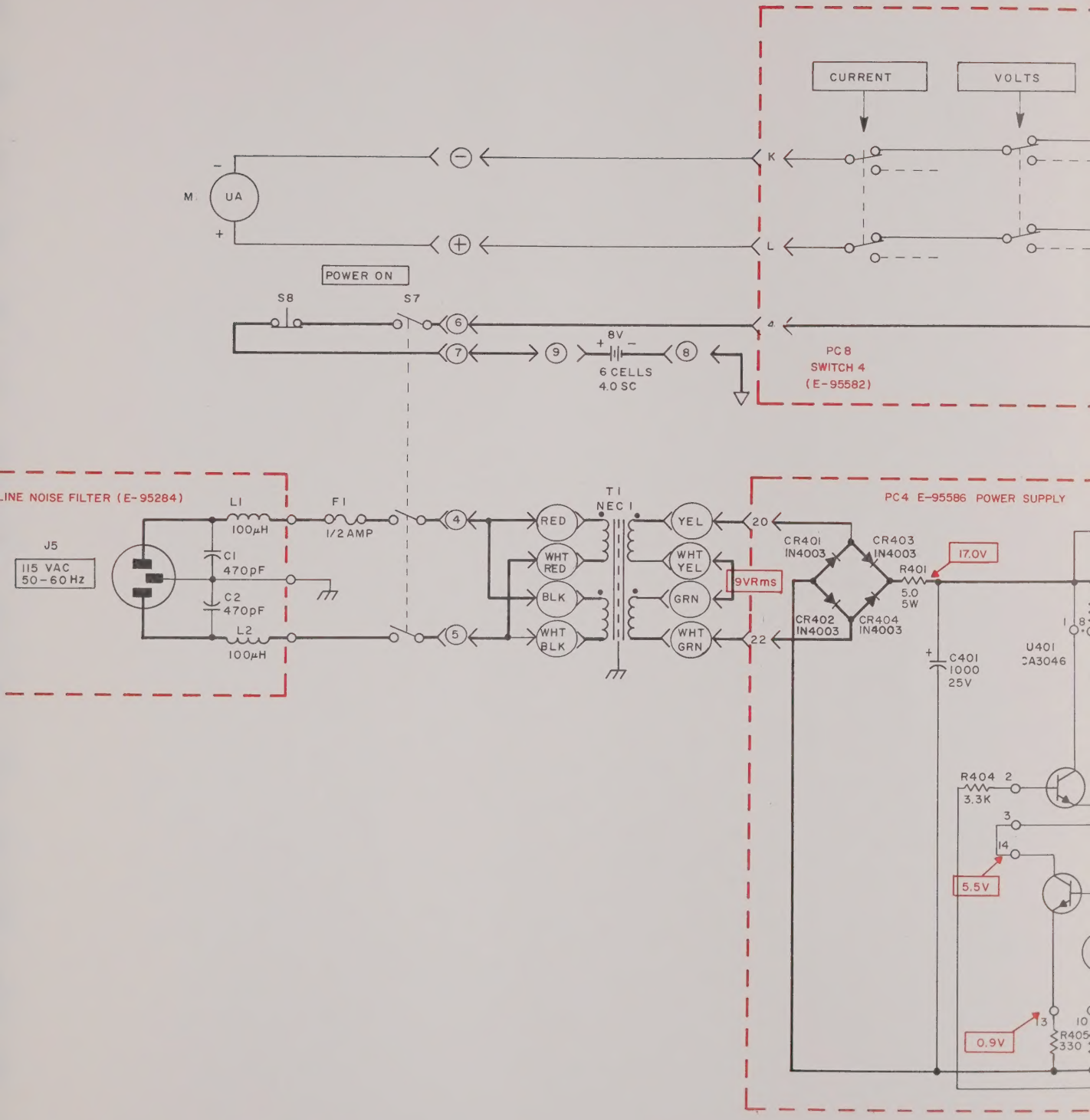
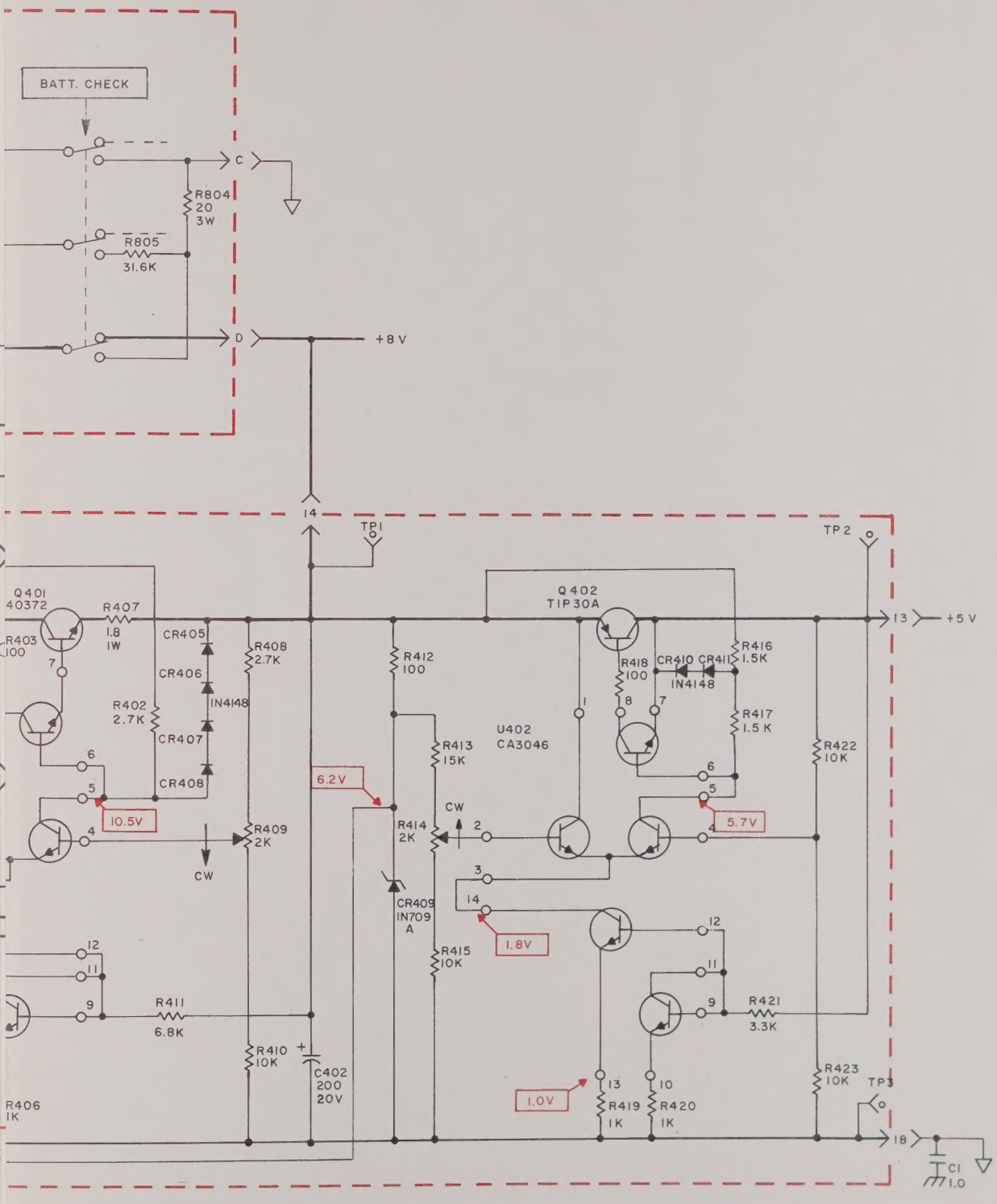



Figure 7-4 Schematic Diagram Error Detector.


CURRENT
VOLTS
M
UA
K
L
POWER ON
S8
S7
8V
6 CELLS
4.0 SC
PC 8
SWITCH 4
(E-95582)
LINE NOISE FILTER (E-95284)
J5
115 VAC
50-60 Hz
L1
100μH
F1
1/2 AMP
C1
470pF
C2
470pF
L2
100μH
T1
NEC I
RED
WHT
RED
BLK
WHT
BLK
YEL
WHT
YEL
GRN
WHT
GRN
9VRms
PC4 E-95586 POWER SUPPLY
CR401
IN4003
CR402
IN4003
CR403
IN4003
CR404
IN4003
R401
5.0
5W
17.0V
C401
1000
25V
U401
CA3046
R404
3.3K
5.5V
0.9V
R405
330




MODEL—7002
BATTERY CHARGER &
VOLTAGE REGULATOR

Figure 7-5 Schematic Diagram Battery Charger and Voltage Regulator.

| Document Title: Product Manuals | Document Number: ESC-1061-92-01 |
|---|---|
| Revision Number: A_X_ B_ C_ D_ E_ | Page: N/A |
| Prepared By: Rick Schultz | Approved By: [signature] |
| Issued By: Jim Steinau | Issue Date: 10/19/93 |

**CHANGE NOTICE SUMMARY**

| Revision | Reason for Change | Date of Change |
|---|---|---|
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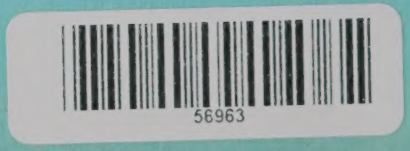
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